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Transportation during Periods of Mobilization: A Historical Review

July 1984

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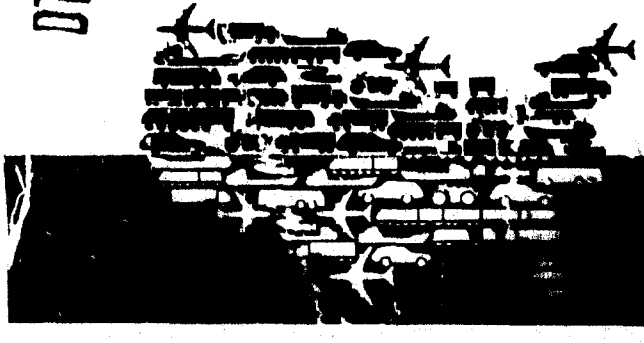

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TRANSPORTATION DURING PERIODS OF MOBILIZATION: A HISTORICAL REVIEW*

Final Report

by

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Energy and Environmental Systems Division

July 1984

prepared for

FEDERAL EMERGENCY MANAGEMENT AGENCY
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The effects on the U.S. transportation system of military preparations for war are compounded by the concurrent transportation requirements of economic mobilization to support a war effort. Several studies of military logistics have concluded that the transportation system may be the limiting factor in determining whether there is a successful operation. The responsiveness of the U.S. transportation system during recent military conflicts is reviewed, beginning with the Spanish-American War and continuing through the Korean War.

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ABSTRACT

The effects on the U.S. transportation system of military preparations for war are compounded by the concurrent transportation requirements of economic mobilization to support a war effort. Several studies of military logistics have concluded that the transportation system may be the limiting factor in determining whether there is a successful operation. The responsiveness of the U.S. transportation system during recent military conflicts is reviewed, beginning with the Spanish-American War and continuing through the Korean War. The nature and scope of each war is characterized, and the associated mobilization is described. Technological developments and regulatory changes in the transportation system since World War II are also reviewed in terms of their implications for the response capability of the nation. The dominant theme that emerges from this study is the overriding need for close coordination between modes and appropriate setting of priorities for shipments. The lack of an efficient system ultimately results in severe congestion at ports and terminals. The critical importance of the merchant marine fleet in overseas conflicts during the previous wars is also identified.

SUMMARY

THE SPANISH-AMERICAN WAR

The Spanish-American War was the first major overseas conflict for the United States. Although the war lasted only four months, it illustrated the types of transportation problems that could be expected during periods of mobilization. Public support of the war was widespread after the sinking of the U.S.S. Maine, but the U.S. was poorly prepared for military and economic mobilization.

The most serious transportation problems were the difficulty of organizing troop transportation to embarkation points and the inadequacy of the U.S. oceangoing fleet. Confusing and continually changing plans for military operations resulted in 25,000 troops being sent to the port at Tampa, Florida. Originally, only 5000 troops were to have been sent there; not only were the port facilities inadequate to handle this volume of men and supplies, but the lack of accompanying documentation, poor coordination, and inefficient loading of ships produced such congestion that railroad cars were backed up on sidings hundreds of miles away.

Although troop assembly and embarkation for Cuba encountered major problems, troops bound for Puerto Rico and the Philippines had relatively few difficulties. However, all overseas transportation was hindered by a common problem. At the beginning of the war, the U.S. had no oceangoing ships. The U.S. had to begin rapidly acquiring commercial vessels and converting them for troop transportation. Eventually the U.S. resorted to chartering and purchasing foreign ships.

The Spanish-American War demonstrated how readily terminal facilities can become congested due to poor coordination. The need for maintaining an ocean-transportation fleet also was clearly shown. The war was won quickly, but no effort was made to remedy the transportation problems. Consequently, many of these same problems recurred a few years later, on a larger scale, when the U.S. entered a global conflict.

WORLD WAR I

The war in Europe had been going on for nearly three years before the United States entered World War I. Nonetheless, the U.S. had made little advance preparation for a major military conflict. The U.S. finally entered the war as a result of indiscriminate sinking of American ships by German submarines.

To some extent the U.S. had begun to mobilize the economy before it entered the war. Food, raw materials, and munitions were being sent to Great Britain and France, but there were not enough reserves to support the two million troops that would eventually be sent to Europe. Although the U.S. government began the war effort by relying on voluntary and cooperative arrangements, the magnitude of the war made it clear that greater control and coordination of the industrial and transportation systems would be required.

When the U.S. entered World War I, the railroads dominated intercity transportation, accounting for 77% of the freight ton-miles and 98% of the passenger traffic. However, chronic car shortages plagued the railroads even before the U.S. entered the war. At the outbreak of the war the railroads attempted to coordinate their operations with an advisory body called the Railroads' War Board. The Board lacked authority and was not able to unify the transportation system. In addition, the federal government's conflicting system of setting priorities for shipments resulted in contradictory instructions from different government shippers. By December 1917, ports and terminals were clogged and railroad traffic in the East was virtually at a standstill.

President Woodrow Wilson, using his emergency powers, directed the Secretary of War to take possession of all transportation systems. One result of this policy was the creation of the U.S. Railroad Administration, which had as its immediate task the clearing of congestion from the terminals and ports. With a system of embargoes and permits, the Railroad Administration cleared the ports and began to coordinate rail traffic. Other steps, such as use of expeditious routes, use of equipment and facilities without regard to ownership, increased demurrage charges, and solid train loads, served to improve the flow of freight.

The most limiting transportation factor affecting the military effort in this war was the uncertain availability of ocean vessels. When the war began, the U.S. ranked a distant third in the size of its merchant marine fleet. Compounding this problem, Allied nations* had lost many ships to the intensive submarine campaign by Germany. The U.S. government quickly seized German ships that had been idle in American harbors since 1914 and appropriated Dutch vessels anchored there, using the old law of angary. A substantial amount of ocean tonnage also was chartered from Norway, Sweden, Denmark, and Japan

Before the war U.S. shipbuilding was nearly nonexistent. Guided by the Shipping Board, the American shipbuilding industry constructed 73 ships in 1917 and 257 ships the following year.

The war revitalized a dormant merchant marine and shipbuilding industry in this country and left the railroads in somewhat better financial and physical condition. The massive mobilization also revealed the importance of modal and intermodal coordination. Just as in the Spanisn-American War, this war showed how easily terminals and ports can become congested when incoming and outgoing freight is not coordinated. These lessons were remembered and applied during the early stages of World War II.

WORLD WAR II

By any measure, U.S. military involvement in World War II surpassed that of World War I. In spite of the vastly greater scale of the Second World War, the U.S. transportation system functioned far better than it had in the First World War, in which the system had been near collapse before the federal government assumed control. Although the U.S. was again a late entrant into the war, it was still not well prepared. Mobilization planning had been carried on but had not been coordinated with the requirements for industrial support or in preparation for a conflict of the magnitude of World War II. When the U.S. did enter the war, manpower mobilization, as usual, was emphasized over equipment and supplies.

In contrast to its actions in the previous war, the federal government did not take possession of the transportation system, except at times when operations were threatened by labor difficulties, such as strikes. Instead the government maintained coordination and exercised supervisory control over the private operations. The principal government agencies that were involved with transportation were the Office of Defense Transportation (ODT) and the Interstate Commerce Commission (ICC). Generally the government relied on cooperation whenever possible, resorting to controls or restrictions only when voluntary efforts failed.

During the war, the railroads hauled the largest volumes of freight in their history. Indeed they bore the major share of the transportation burden. Not only did

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*The principal Allies (Entente Powers) in World War I were France, Great Britain, and Russia. These countries were joined by Italy, Japan, the United States, and various smaller nations.

they transport over two-thirds of total intercity freight during the war, but the railroad system was strained by record increases in freight shipped each year. Destruction of coastal and intercoastal vessels by German submarines also contributed to a surge in rail traffic.

Traffic on the Great Lakes and inland waterways increased little during the war. Lake shipping was limited by the availability of vessels and the lack of year-round navigation. The inland waterways were not used to capacity, because the slow speed of towboats made barge shipping relatively unresponsive to the pressing needs of the war. The motor carriers also experienced a significant decline in traffic due to shortages of vehicles, parts, tires, fuel, and manpower.

Although the United States incurred no war damage to its inland transportation system, the damage caused to its coastal shipping by enemy submarines had widespread consequences for the inland modes. The railroads had to haul larger volumes of freight over greater distances; new routes had to be established. In addition, the petroleum pipeline network was significantly increased.

Again as in the two previous wars, ocean transportation was the transportation factor of greatest direct significance to the war effort. The movement of troops, supplies, and equipment to foreign ports was directly related to the availability of ocean shipping. As a result, the supply of oceangoing vessels affected the timing of military campaigns and the number of troops that could be provided.

The experience of World War II showed that the transportation system could function smoothly in the critical early stages of a massive military and economic mobilization if there was sufficient coordination to ensure efficient transfer of freight between modes, preventing congestion at terminals and ports. Although no one had been prepared for the magnitude of the war effort that developed by 1942, it was not necessary for the government to assume ownership of the transportation system. Centralized control was necessary and, as the war became prolonged, it was evident that government-agency coordination was as important as modal coordination. In spite of persistent and continuing problems, the transportation industry -- in concert with the federal government -- met the extraordinary demands of the war.

THE KOREAN WAR

Although the Korean War lasted for nearly three years, it differed considerably from the three previous foreign conflicts. The theater of operations was small, not global; the U.S. was not a late entrant into the war, as it had been in World Wars I and II; and the war was treated as a limited conflict. In spite of the exhaustion of much of the Army's reserve supplies and equipment during the early stages of the war, the American economy was never placed on a full wartime footing. The impact of an extensive industrial mobilization was never felt. Since the Office of Defense Transportation had expired in 1949, President Harry Truman designated the Interstate Commerce Commission to allocate and assign priorities for transportation facilities and shipping. The ICC used many of the same kinds of controls that the ODT had used in World War II to regulate the flow of freight.

A threatened strike by trainmen and conductors in 1950 caused President Truman to place the Class I railroads under the control of the Department of Defense. However, the control was relatively superficial compared with that in World War I. The railroads were returned to their owners as the labor situation eased.

Because the war was considered a limited conflict, there was little effect on either the total freight volumes or the post-World War II trends in the modal distribution of intercity freight traffic. Perhaps one reason the domestic economy and transportation system were not drastically affected was that the U.S. took advantage of Japan's proximity to the war zone. In 1950 the U.S. forces still controlled Japan's industrial resources. By reconditioning large quantities of World War II equipment still in Japan and purchasing supplies from both Japan and South Korea, much of the shortage in American-produced shipments could be eliminated.

The most notable transportation development that occurred during the Korean War was containerization for overseas shipping. Cargo transporters, which were reusable containers, combined small packages into uniform loads. This system was estimated to save 25 to 30 days in shipping material from depot to depot.

TRANSPORTATION DEVELOPMENTS SINCE WORLD WAR II

Numerous technological improvements and regulatory changes have occurred during the 40 years since World War II. Many of these changes will affect how the transportation system will respond to a future crisis or mobilization requirements.

Of major significance is the substantial growth of freight traffic after World War II. During the war, record volumes of freight were shipped -- nearly twice the total shipped just prior to the war. However, every year since 1951 the annual ton-miles of intercity freight have exceeded the record volumes of 1944. The greatly enlarged transportation capacity is the result of consolidation and efficiency improvements in the rail system, construction of a vast intercity highway network (coupled with growth in motor freight transport), containerization, improvements in intermodal transfer, and regulatory reform.

The U.S. merchant marine fleet has been severely depleted since the end of World War II. At the end of that war, the U.S. had the world's largest fleet of commercial oceangoing vessels. By 1982 this country's merchant marine fleet ranked only eleventh in size. In previous overseas conflicts, ocean transportation was the most limiting logistical factor. Except for the Korean War, the U.S. faced a dire shortage of ships in each of these wars. As a consequence, it would appear that the erosion of the merchant marine fleet seriously undermines the U.S. response capability and ultimately the nation's security.

1 INTRODUCTION

The evaluation of the concept of industrial protection is a complex public policy problem. The U.S. has a large, technologically sophisticated industrial capability. Manufacturing facilities, which are dispersed throughout the country, serve both military and civilian customers. In the event of a military conflict, many industries must quickly respond to sizeable changes in demand for their products or services, with considerable stresses placed on their capacity. In addition, since most facilities have operated principally in the civilian economy, security has not been an overriding concern. Consequently, the U.S. industrial capability is not only vulnerable to the threat of war, both conventional and nuclear, but also to the consequences of natural disasters or sabotage.

Because of the widely dispersed nature of industrial activities in this country, the transportation system figures prominently in the evaluation of the viability of industrial protection. Not only is the transportation system vulnerable to the same types of damage as the industrial facilities, but it is also subject to the same stresses that could be expected during a mobilization. Indeed, without careful planning, the transportation system could be the limiting factor in a massive national effort to prepare for war. The transportation network, as well as the vehicles themselves, will play a critical role in any crisis-generated relocation activity.

The critical nature of the transportation system seems obvious, given that military success depends upon the timely transportation of military personnel and their supplies. In large part, the armed forces must rely on a civilian transportation system that during this century has served a military that has grown significantly in size and complexity of equipment. During periods of mobilization, the domestic transportation system is stressed in several ways. The impact of military mobilization is accompanied by concurrent economic mobilization. Manufacturing output typically reaches record levels, while at the same time military transportation requirements are surging Indeed, the transportation requirements of economic mobilization are likely to exceed those for direct military support.

In order to evaluate the role of transportation in a mobilization effort, a literature survey was undertaken. This survey was necessary for two reasons. First, we quickly discovered that while problems involved in military mobilization have been examined extensively, the focus has been on the deployment of military forces. Past studies have concentrated on military logistics, with little attention paid to the civilian transportation requirements needed to support the military. Furthermore, none of this information is readily available in a single document that could be used in a public policy decision. Second, one of the overriding conclusions of several researchers is that the U.S. in each of its conflicts has been able to mobilize personnel faster than it has been able to equip and supply them. Shortages at the battlefront were most likely to be due to some limitation in the transportation system.

This review of transportation during periods of mobilization begins with the Spanish-American War, the first conflict in which there was mobilization activity that is relevant to the nation's modern transportation system. The review continues through both World Wars and the Korean War. Little information relevant to mobilization issues

is available from the literature on the Vietnam War, principally because there was such a gradual escalation that the transportation system, while moving massive amounts of personnel and materiel, was not typically subjected to acute stresses.

In addition, changes in the transportation system that have taken place since World War II are examined. This explanation of transportation developments, coupled with assessments of how the transportation system functioned during previous military conflicts, suggests where problems could be anticipated in the future as well as changes likely to eliminate some of the problems that have occurred in the past.

2 SPANISH-AMERICAN WAR

Theodore Roosevelt called it "a splendid little war." Although the war against Spain in 1898 lasted less than four months, it was the United States' first venture into a major overseas military conflict. More important, events during the Spanish-American War presaged some of the transportation problems the United States would experience again in World War I. Thus, the Spanish-American War provided some lessons on industrial mobilization for war -- lessons the United States would painfully relearn in 1917.

2.1 NATURE OF CONFLICT

The Spanish-American War had its origins in the Cuban insurrection against Spanish rule in 1895. Spain countered the rebels' violence with increasingly repressive measures. Many Cubans fled to the United States, bringing with them numerous stories of Spanish atrocities. These stories were widely publicized by the American press and helped to build public pressure on Congress and the President to intervene militarily.

The situation simmered for several years. Then, on February 15, 1898, the U.S.S. Maine exploded and sank in Havana Harbor, supposedly as a result of contact with a submarine mine. The United States demanded that Spain withdraw from Cuba and recognize the island's independence. When Spain refused, the Congress in mid-April gave President William McKinley the authority to use American troops to expel the Spanish forces from Cuba. On April 23, 1898, the United States declared war on Spain.

The war against Spain was fought on two fronts. In the Caribbean, an American expeditionary force quickly overcame the Spanish forces, first in Cuba and then in Puerto Rico. The Santiago campaign ended on July 17, 83 days after the declaration of war. In the Philippines, Commodore George Dewey led a force that attacked and destroyed a Spanish flotilla in the harbor of Manila. By August 13, 1898, only 110 days after war had been declared, the Puerto Rican and the Philippine campaigns were successfully completed, and the United States and Spain signed a preliminary peace treaty.

2.2 NATURE OF MOBILIZATION

Despite the public's apparent eagerness for military intervention against Spain in Cuba, the United States was ill-prepared for war in 1898. After the Civil War, the federal government had made very little effort to maintain a large military establishment, and the Cuban revolution in 1895 had produced no change in this policy. Congress did not significantly increase the War Department's budget, nor did the War Department do much in anticipation of war. Even the destruction of the battleship Maine, despite its effect on the public's emotions, did little to spur the government or the military into preparing for war. The War Department, in fact, did not greatly modify its peacetime routine.[1]

In those days, the emphasis was on manpower mobilization rather than industrial mobilization. Many in the government and the military believed that large numbers of troops could be equipped and supported more quickly and easily than they could be conscripted and assembled. A few people questioned this tenet, but to no avail. The philosophy and administration of military logistics had not changed much since the War of 1812.

More serious than the undue emphasis on manpower mobilization was the government's and the military's inability to recognize the significance of rapidly expanding U.S. industrial power in the 1890s. Consequently, the government did not take full advantage of the country's industrial potential to develop materiel reserves and industrial mobilization plans. No provisions were made for stockpiling arms, ammunition, food, clothing, and other equipment. The regular Army and the National Guard, though small, were ill-equipped. The federal government relied on the states to supply the initial equipment for the volunteers. State troops, however, were seldom fully armed; the troops equipped themselves, and what equipment they did have was often in poor condition.[1]

2.3 TROOP CONCENTRATION AND EMBARKATION AT THE PORT OF TAMPA

Despite the limited duration and nature of the Spanish-American War, the United States encountered some serious transportation and logistical difficulties. Although poor or limited transportation facilities contributed to these problems, the primary causes were inadequate planning, hasty mobilization, lack of coordination. and the absence of transportation controls.

Imprecise planning more than anything else was the root of the Army's transportation difficulties. Before war was declared, the War Department did not prepare any detailed plans for military operations against Spain. When the war started, the plans that were developed were continually changed. Questions about the logistical feasibility of certain elements of these plans were not given proper consideration. Consequently, neither the Army nor the railroads were ready to handle the mass movement of troops and supplies to Tampa, Florida.

The Port of Tampa was chosen to be the point of embarkation for the Santiago campaign. The situation there soon became chaotic. At first, only 5000 troops were to have been assembled there. However, because plans were constantly being changed, 25,000 troops ultimately converged on the area. The port lacked the facilities necessary to handle that many men and their supplies. Many of the early shipments arrived without invoices or bills of lading. Some of the consignees, therefore, broke open the railroad cars to find their consignments. The lack of documentation, along with the inadequacy of unloading and warehousing facilities, caused numerous delays. Consequently, the two railroads that served the Tampa area quickly became congested. Approximately 1000 railroad cars were backed up on sidings from Tampa to as far away as Columbia, South Carolina.[1]

Poor wharf facilities, lack of coordination, and inefficient methods prolonged the loading of the ships. The Army attempted to "combat-load" each vessel (i.e., each vessel

was to carry a self-contained fighting unit completely prepared for battle). Because full cargoes were seldom on hand, the ships often had to be pulled out to the harbor and then returned to complete the loading. Many of the rations had to be handled several times. Guns were often mounted on their carriages before they were placed on board. The performance was embarrassing but not entirely ineffective; by the second week of June, nearly one and a half months after war had been declared, all of the troops and some of their equipment left Tampa for Santiago de Cuba.

By contrast, the embarkation of troops for the Puerto Rico and Philippines campaigns proceeded fairly smoothly except for the problem of finding oceangoing vessels. Instead of using only one port of embarkation for the expedition to Puerto Rico, the Army dispatched 3,571 officers and men from Charleston, South Carolina; 2,896 from Tampa, Florida; and 5,317 from Newport News, Virginia. These were joined by 3,415 troops stationed at Guantanamo.[1] All 15,800 of Admiral Dewey's officers and men bound for the Philippines embarked at San Francisco. These forces, however, left in contingents of 2,500, 3,500, 4,800, and 5,000 men between early June and the end of July.[1]

2.4 OCEAN TRANSPORTATION

At the beginning of the Spanish-American War, the Army had no oceangoing vessels and no experience in ocean transportation. To find enough ships to send an expeditionary force to Cuba, every American-registered vessel operating along the Gulf and Atlantic coasts was considered. By the end of April, about a week after the declaration of war, the Army's fleet included only three or four freighters. By May 26, there were about 30 freighters in the fleet.[1] All of these ships had to be ventilated and converted to transport troops. The quartermaster officers greatly overestimated the troop-carrying capacity of these vessels. Because existing shipbuilding facilities were inadequate, the U.S. government resorted to purchasing additional ships from foreign sources to support the war effort.[2] For example, the United States had to charter 18 foreign vessels and purchase two others to transport Admiral Dewey's forces to the Philippines.[1]

2.5 SUMMARY

Although the United States won the war against Spain, the manner in which the nation's armed forces had been mobilized for the expedition to Cuba was clearly inadequate. Public dissatisfaction with the War Department's performance was widespread, and President McKinley consequently appointed a commission, known as the Dodge Commission, to investigate the conduct of the war.

The war should have taught numerous lessons about the need for better logistics planning and administration, as well as the importance of materiel preparation over manpower mobilization. It clearly demonstrated the inefficiency and obsoleteness of the War Department's existing methods of mobilization and logistics support. The war showed how easily ports and other terminal facilities can become congested when the movements of troops and supplies are not coordinated with the availability of ships and

port facilities. It revealed the importance of coordinating the movement of men and equipment to ports of embarkation with the availability of unloading facilities, warehousing, railroad-car storage space, and oceangoing vessels. With regard to the latter, it clearly demonstrated the need for an ocean transportation service under military control.

The war against Spain was won so quickly and easily, despite the numerous logistics and transportation problems, that these lessons were either not learned very well or were soon forgotten. Because the war was over so quickly, the Army found little need or opportunity to improve its methods of mobilization and logistical support. Consequently, in the years between the Spanish-American War and World War I, very few supplies and equipment items were stockpiled, and very little planning for industrial mobilization was undertaken. In 1917, the United States repeated on a larger scale many of the same mistakes made in 1898.

3 WORLD WAR I

The United States was a late entrant into World War I; nearly three years elapsed between the time hostilities began in Europe in August 1914 and the time the United States declared war on Germany in April 1917. In all that time, despite the constant threat of German submarines to American shipping, the U.S. government did very little to prepare the country for participation in a major war overseas. Consequently, when the time came to mobilize in the spring of 1917, the American people and their economy faced an unprecedented challenge. That the United States was able to respond so quickly testified to the flexibility and capacity of the country's industrial and transportation systems.

3.1 NATURE OF CONFLICT

Before entering the war, the United States had sought to remain neutral. Consequently, when the British naval blockade of Germany had prevented American exports of food and raw materials from reaching the latter nation, the U.S. State Department had complained to Great Britain. The disagreement, however, was not major, and soon the United States became the primary source of food, raw materials, and munitions for the British and French armed forces. As will be seen shortly, the resulting increase in exports began to strain the eastern ports and railroads of the United States.

The United States might not have entered the war had it not been for Germany's submarine warfare. The Germans threatened to torpedo Allied ships without warning, thereby endangering the lives of Americans traveling and working on Allied vessels.* The first major incident involving Americans occurred on May 7, 1915, when a German submarine sank the unarmed British liner Lusitania without warning. Among the dead and missing were 128 Americans. Other incidents followed in 1915 and 1916. On January 9, 1917, the German leaders launched an all-out submarine war against the shipping of all neutral and Allied countries. The United States severed diplomatic relations with Germany on February 3, 1917. When the Germans began to sink American ships indiscriminately in March of that year, President Woodrow Wilson asked Congress for a declaration of war. On April 6, 1917, the United States officially entered the war against Germany and the Central Powers.**

From the Allies' standpoint, the broad objective of American military involvement was simple: to pour as many American troops into France as available ocean transportation would allow and worry about supplies and equipment later. In effect, the Allies hoped to overwhelm the Germans by the sheer force of numbers before

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*The principal Allies (Entente Powers) in World War I were France, Great Britain, and Russia. These countries were joined by Italy, Japan, the United States, and various smaller nations.

**The Central Powers allied with Germany in World War I were Austria-Hungary and Turkey.

the problem of maintaining and supplying such a large force became intractable. By the end of the war, the American Fxpeditionary Force (AEF) in France consisted of 81,800 officers and 1,892,600 combat and service troops.[1]

3.2 NATURE OF MOBILIZATION

The continuing debate on the importance of manpower mobilization over materiel mobilization hampered the United States' efforts to prepare for war. The notion of a large regular army backed by a large body of trained reserves was still quite popular. The General Staff even warned that some people were exaggerating the importance of materiel preparedness over manpower mobilization in modern warfare. On the other hand, a few influential people, both within and outside of the military, did recognize the significance of materiel reserves and industrial preparedness. Among them was Howard E. Coffin, a member of the Naval Consulting Board, who established a Committee on Industrial Preparedness. The Committee surveyed industrial plants throughout the country, analyzing their capacity to produce military supplies and munitions.

The upshot of the public debate over manpower versus materiel preparedness was that neither was effectively achieved. The National Defense Act of 1916 provided for a modest increase in the Regular Army, a National Guard that could be called into federal service, and an Officers Reserve Corps. The Act also gave the President broad powers to effect industrial mobilization in time of war. The emphasis of the Act, however, was on mobilizing troops rather than industry. President Wilson, influenced by the activities of the Committee on Industrial Preparedness, urged Congress to create a mechanism for mobilizing the nation's economic resources in the event of a national emergency. The Congress responded by attaching a rider to the Army Appropriation Act of 1916, establishing a Council of National Defense to coordinate the nation's industries and resources "for the national security and welfare." The Council's function was to plan and coordinate; it had no power to execute a plan to prepare the nation's economy for involvement in the war in Europe.

To some extent, the American economy was already on a war footing in 1915 and 1916. As mentioned previously, the United States had been supplying Great Britain and France with large quantities of food, raw materials, and munitions during those years. The Army, too, was in a greater state of readiness than it might otherwise have been because of the large-scale mobilization of troops along the Mexican border in 1916.

Nevertheless, when the United States entered the war in April 1917, it did not have enough materiel reserves to support the large number of troops being sent to France. The United States, therefore, initially had to rely on the available industries of France and Great Britain to supply and equip the AEF.

The mobilization and wartime control of the American economy occurred in two distinct stages. Between April and December 1917, the U.S. government relied primarily on voluntary and cooperative efforts. It became increasingly clear, however, that the federal government was going to have to exert greater control over the nation's industries and transportation system if the pressing demands of the war were to be met.

Consequently, after December 1917, the U.S. government took the unprecedented step of exercising complete control over every important aspect of the nation's economy. The railroads were nationalized, strict controls were imposed on industry, food and fuel were rationed, a large merchant fleet was constructed, and coercive measures were employed to prevent strikes.

The agency primarily responsible for organizing and controlling the industrial effort was the War Industries Board. The Board was composed of 57 commodities sections. Each section consisted of experts in a particular industry as well as representatives from the Army, Navy, and other interested procurement agencies. The Board classified each industry, and even certain plants within an industry, according to relative importance in the war effort. The Board then coordinated all industrial activities, allocating work orders among factories to control the distribution of raw materials and finished products. The Board also worked to conserve the use of materials and labor, encouraged industries to produce the maximum output of needed supplies, and established maximum prices for goods in short supply.

During the war, the U.S. government also either built or financed the building of numerous munitions plants. These included 16 factories for the production of powder and high explosives; 16 plants for loading shells, bombs, grenades, boosters, fuses, and propellants; five new gun factories; four nitrate plants; and eight facilities for manufacturing toxic gas and gas masks and for loading gas shells.[1]

3.3 TRANSPORTATION WITHIN THE UNITED STATES

At the time the United States became involved in World War I, the railroads were the primary mode of intercity transportation. In 1916 the railroads handled 77.2% of all intercity freight ton-miles and 98% of all passenger-miles.[3] Motor carriers, which hauled an insignificant amount of freight, primarily augmented rail operations and provided local pickup and delivery service. Thus, the railroads had to transport virtually all of the troops and most of the intercity freight during the war.

In April 1917, several hundred railroad companies were operating in the United States. These companies owned a total of 400,000 miles of track, including 260,000 miles of first main track. However, 76.9% of this trackage was owned by the 32 principal railroad systems.[4]

3.3.1 Prewar Difficulties of the Railroads

During the years preceding the entrance of the U.S. into the war, the railroads were not in a particularly strong position to handle the increased traffic that would be generated by the war. First, the carriers were having problems raising enough investment capital to expand and improve their rolling stock and facilities. "Full crew" laws, limits on the length of trains, higher wages, eight-hour work days for train crews, and elaborate work rules prescribing work conditions highly favorable to labor were pushing operating costs up rapidly. On the other hand, state regulations, the extreme competitiveness of the railroad companies, and the reluctance of the ICC to grant rate increases were keeping transportation rates down.

Because the railroads were unable to expand and improve their physical plant, car shortages were becoming a chronic problem, especially in the fall and winter when large quantities of grain and coal had to be transported. These shortages did not necessarily occur because of any deficiency in the number of cars. In 1916 the Class I railroads owned 2,253,233 freight cars with an aggregate capacity of 92,280,335 tons; on the average, only 6.2% of these cars were out of service awaiting repairs.[5] Rather, the primary cause of the chronic car shortages was the uneven distribution of the equipment. Some railroad territories had an insufficient number of cars, forcing mills to close, prices to rise, and perishable items to spoil. Other territories, conversely, had a surfeit of cars. Much of this excess equipment, however, was tied up at the ports and other terminals. The railroads had adopted car service rules, but these rules were generally inappropriate for the situation, and the railroad companies, because of their intense competitiveness, did not always follow them anyway.

Even before the United States entered the war as a combatant, the railroads were having difficulty handling traffic. France and Great Britain were purchasing large quantities of food, raw materials, and munitions from the United States. The resulting heavy flow of exports was causing serious congestion at the nation's eastern ports. Storage facilities became saturated with goods waiting to be loaded on ships that often arrived late or not at all because of the vagaries of weather and war. Rail cars waiting to be unloaded clogged the ports, while other cars consigned to ports clogged terminals further inland. As a result, by December 1916, the railroads were faced with the worst congestion and concomitant shortage of freight cars in their history. Thus, when the United States entered the war in April 1917, the railroads' situation was already bad.

3.3.2 Movement of Troops

Thanks to early planning and extensive cooperation with the military, the railroads were able to handle the movement of several million American troops without undue difficulty. As early as 1914, because of threatening developments in Mexico and the outbreak of war in Europe, the American Railway Association (ARA) was meeting with government officials in Washington, D.C., to discuss how the railroads might cooperate with the military in the movement of troops and supplies. In 1915 the ARA, at the suggestion of the Secretary of War, appointed a special committee on cooperation and coordination with military authorities. As a result of these activities, by June 1916 a plan had been formulated for unifying the railroads for the handling of troop movements.

Under the new system, an executive in Washington, designated by the ARA's special committee on national defense, dispatched all troop-carrying trains. An agency of the ARA maintained field offices throughout the United States. It assigned a general transportation agent at the headquarters of each of the Army's six geographic departments. It also assigned an agent at each camp or port receiving or dispatching troops. Each major railroad appointed an officer to be in charge of troop transportation in cooperation with the general agents at the Army's six geographic-department headquarters. In this way, the railroads were able to achieve coordination among themselves and with the military in expediting the movement of troops.

Between May 1, 1917, and November 10, 1918, the railroads transported more than five million military passengers.[6] To keep from overtaxing the railroad system the number of draftees was initially kept small, and the conscripts traveled on regular trains. However, by September 1917, special trains were hauling men to military camps all over the country. As many as 50,000 men a day and 400,000 a month were carried over the rails.[1]

As an example of the kinds of troop movements involved, consider the case of the 18,800 men of the Eighth Division. Forty-two trains were used to transport these men over the 3,444 miles between Camp Fremont in California and Camp Mills on Long Island. Six trains were dispatched daily every 90 minutes over a period of seven days. The trains made the journey in an average time of seven days and three hours. The trains were routed over different lines to prevent serious congestion.[1]

3.3.3 Movement of Freight by Rail

Whereas the railroads were able to handle the movement of troops without encountering any major crises, the movement of export freight was chaotic from the start. Numerous factors contributed to the almost disastrous situation. Perhaps the single most important factor was the lack of centralized control over the transportation system when the United States entered the war.

Cooperative Attempts to Unify the Railroads

As was mentioned in Sec. 3.2, the mobilization of the American economy in World War I was marked by two distinct phases. During the initial phase, lasting until the end of December 1917, the U.S. government relied quite heavily on the voluntary efforts of industry to meet the nation's wartime needs. Thus, the railroads attempted to coordinate or unify their operations through voluntary efforts initiated by the industry itself.

To achieve self-coordination, the major railroads established an advisory body known as the Railroads' War Board. It consisted of a 33-member executive committee supported by approximately 700 railroad executives. The Board had no authority to issue orders or enforce its demands. Rather, it had to persuade, educate, and apologize. Although it was not able to avert the ultimate overloading of the railroad system near the eastern ports, it did effect some improvements in the efficiency of railroad operations. The efforts of the Board, for example, resulted in improved car service rules (as well as more widespread compliance with these rules), the pooling of box cars, heavier carloads, the discontinuation of over 28 million passenger-train miles, better coordination in the handling of exports, the pooling of lake and tidewater coal (as well as faster handling of coal at the terminals through reductions in the number of coal classifications), more expeditious movements of troops between military posts and ports of embarkation, and more expeditious handling of building materials and supplies for cantonments.[4]

Despite these accomplishments, the Railroads' War Board was not able to achieve the degree of coordination or unification necessary to prevent the eventual breakdown of the transportation system in December 1917. There were several reasons for the Board's failure. The Board's efforts to coordinate railroad operations were constrained by existing government regulations. These regulations either discouraged or prohibited any form of cooperation among the rail carriers. The Interstate Commerce Act of 1887, for example, prohibited competing railroads from entering into any kind of pooling arrangement. Neither Congress nor the Justice Department was willing to suspend these rules for the sake of aiding the war effort. Another reason for the ultimate failure of voluntary efforts at coordination and unification was the absence of any government compensation for revenue lost by railroads that voluntarily surrendered traffic or equipment to other lines. This, combined with the railroads' natural competitiveness, was a powerful disincentive for voluntary cooperation. Because the Railroads' War Board had no power to enforce its demands, there was little it could do outside of persuading and apologizing to compel the railroads to comply with its requests.

The Uncoordinated Priority System

Even had the railroads been able to unify their operations entirely on their own, it is doubtful that they could have prevented the breakdown of the transportation system. The federal government's complex and often conflicting system of assigning priorities for shipments would have tied up even a unified rail system.

The various federal procurement agencies were given the authority to require the railroads to give a high priority to designated shipments of government freight. Consequently, the War Department, the Navy Department, and the Shipping Board arranged to have the Railroads' War Board institute a system of tagging government freight for expedited handling. Unfortunately, these departments failed to coordinate their shipping activities. It was not long before virtually all government freight was being tagged by government agents throughout the country. No consideration was given to how soon the goods involved were needed nor to the ability of the consignees to receive and unload them. The railroads were often faced with having to comply with conflicting instructions from different government shippers.

Congestion at Ports and Terminals

As a result of the lack of coordination at the federal level, railroad traffic in the East came to a virtual standstill by December 1917. All terminals along the Atlantic seaboard and in the eastern industrial districts were clogged. The Port of New York was especially hard-hit, with 200 ships anchored in New York Harbor waiting for cargo and fuel. Nearly two million tons (44,320 carloads) of freight were stalled along the Atlantic coast and as far west as points along the Missouri River.[1,4] It took as long as two weeks to move trains through the terminal at Pittsburgh.[3]

Government Seizure of the Transportation System

By December 1917, it was clear that federal control of the domestic transportation system was essential. On December 26, 1917, President Wilson, employing the emergency powers granted to him under the National Defense Act of 1916, directed the Secretary of War to take possession of not only the railroads but every transportation system in the country. The President's directive took effect two days later. The U.S. Railroad Administration was created as a result of the federal government's takeover of the railroads. The Secretary of the Treasury was appointed as the Director General of the Railroads. Below him were the directors for each of the seven regions, the district directors, and the federal managers assigned to each of the railroads. Most of the central and regional officers of the U.S. Railroad Administration were affiliated with the railroad companies. Most of the federal managers, for example, were the principal operating officers of the railroad companies they were assigned to cover. These officers and managers had to sever their connections with the carriers and become the exclusive agents of the federal government The U.S. Railroad Administration encompassed eight divisions covering the areas of law, finance and purchasing, operation, traffic, labor, public service and accounting, capital expenditures, and inland waterways.

Unclogging the Ports and Terminals

The U.S. Railroad Administration's immediate task was to free the ports and other terminals from congestion. This involved clearing out the cars already at the ports and creating a mechanism for regulating the future movement of export freight to the ports.

The U.S. Railroad Administration's first action was to impose an embargo on all freight consigned to a port, including all Army freight. This was done so that the cars that were already at the ports could be unloaded and cleared out. In November 1917, there were approximately 90,000 more freight cars waiting at ports and terminals than was normal. By February 1918, the number had increased to approximately 200,000.[4] In clearing out these cars, the Railroad Administration ignored all previous priorities. The cars that were unloaded first were the ones that were easiest to reach.

Next, the U.S. Railroad Administration replaced the priority system with a system of permits. The permit system was designed to coordinate the movement of rail traffic to the ports with the availability of oceangoing vessels. Before any export freight could be loaded into railroad cars, the shipper or consignor first had to apply for a permit from the Railroad Administration. To obtain a permit, the shipper had to provide assurances that ships would be available at the port to receive the cargo.

In June 1918, an Exports Control Committee was established to aid in coordinating the movement of export traffic with the availability of ocean transportation. The committee was composed of representatives from the U.S. Railroad Administration, the Department of War, the Department of the Navy, the Shipping Control Committee, and the Allies. The committee, which closely monitored the availability of oceangoing vessels, had the authority to select the port to which a shipment of freight would be consigned.

Besides embargoes and permits, the U.S. Railroad Administration took other steps to improve the flow of rail freight to the ports. These measures included short routing over the most expeditious routes, unification of facilities and equipment and their use without regard to ownership, increased demurrage charges, immediate unloading and transfer of cargo for later delivery to the consignee, a "sailing day" plan for less-than-carload freight, and solid train loads. Because most of these measures were applied to rail traffic in general and not just to export freight, they are described in more detail in the following section.

Control over Rail Traffic

The system of embargoes and permits applied not only to export traffic but to all other rail shipments as well. Whenever a terminal became congested or was on the verge of becoming congested, an embargo was placed on all rail traffic bound for that terminal until conditions improved. Freight could not be loaded into rail cars without a permit from the U.S. government. To obtain a permit, the shipper had to assure the government that the freight could be promptly unloaded at its destination.

With the embargo and permit system came better coordination at the federal level. Better coordination within the War Department improved the movement of military freight, and better coordination among all federal agencies improved the movement of all rail freight, both military and commercial.

Shortly after the government took over the railroads, the War Department began to centralize its transportation activities. Previously, each supply bureau within the War Department had made its own arrangements with the railroads for transportation of the supplies for which it was responsible. At first, there was no coordination among the bureaus at all. Then, in August 1917, the Department formed the Embarkation Service. The supply bureaus were supposed to obtain a permit from the Service before shipping any materials to a port. The Embarkation Service, however, had no authority to back up its rulings, which were sometimes disregarded. On January 10, 1918, the War Department abolished the separate transportation units in the various supply bureaus and organized the Inland Traffic Division, which later became known as the Inland Traffic Service. This organization was able to provide the strict coordination of military traffic that had previously been missing. No War Department bureau or government contractor could load any freight consigned to an embargoed area without first obtaining a permit from the Inland Traffic Service. If the cargo was destined for overseas, a release had to be obtained from the Embarkation Service.

To achieve government-wide coordination, the Director General of Railroads formed a committee of traffic experts from the Inland Traffic Service, the Navy, the Food and Fuel Administrations, the U.S. Shipping Board's Emergency Fleet Corporation, and the War Industries Board. These managers of inland traffic met weekly to determine the priorities for virtually all government shipments.

The Railroad and Fuel Administrations worked together to control the movement of coal by rail. Zones were established for each mine, and coal shipments beyond the limits of each zone were not allowed. This prohibition eliminated much cross hauling and

many unnecessarily long hauls and also saved a considerable amount of coal for the railroads.

Control over the Use of Rail Equipment

As was mentioned in Sec. 3.3.1, the railroads faced recurring shortages of freight cars even before the United States entered the war. The increase in traffic due to the war intensified the problem. By May 1917, the shortage of cars was estimated at around 164,000, the worst ever experienced by the railroads up to that time. The shortage was reduced somewhat during the following summer, but by November 1917, it was back up to 150,000 cars.[4] Consequently, when the U.S. government took possession and control of the railroads, a great deal of attention was given to the problems of conserving and maintaining existing cars and locomotives, procuring and allocating new equipment, and maintaining existing trackage.

Several measures were taken to conserve freight cars. To increase the loading of cars, private shippers resorted to changing the sizes of containers and double- and triple-tiering cars. Less-than-carload (LCL) freight posed a special problem. To increase the loading of LCL freight, the U.S. Railroad Administration implemented the "sailing day" plan. Instead of being handled each day, shipments of LCL freight were concentrated at large centers for dispatching to smaller points on certain specified days. This plan resulted in full carloads between shipping points and destinations and eliminated the need to transfer freight at intermediate points. To discourage undue holding of freight cars by shippers and consignees, demurrage charges were increased to $3.00 per car for each of the first four days after the free period, $6.00 for each of the next three days after that, and $10.00 for each day thereafter.[4]

The Railroad Administration was able to unify railroad operations, something the railroads themselves had been unable to do voluntarily. Under federal control, little consideration was given to which railroad owned the cars or over whose line the traffic was routed. Thus, the Railroad Administration was able to eliminate much circuitous routing. Because it had unified control over the distribution of refrigerator and tank cars owned by the private car lines, it was able to coordinate the movement of privately owned cars with the movement of refrigerator and tank cars owned by the carriers. Terminal facilities were also unified under federal control. For example, the Railroad Administration could use the repair shops of one railroad to repair locomotives and freight cars belonging to other carriers.

Table 3.1 shows the effects on railroad operating efficiency both of initial voluntary efforts of the railroads and of subsequent federal control during World War I. Rail traffic increased 8.8% during the first year the U.S. was in the war, and it increased an additional 2.6% during the second year. The average length of haul of a ton of rail freight increased 3.7% between 1916 and 1917 and 3.0% between 1917 and 1918. Under private control, the net tons per train went up 6.3% in 1917 over 1916, and the average loading of a loaded freight car went up 8.0%. Under federal control in 1918, the net tons per train increased 4.9% over 1917 and 11.5% over 1916. The average loading of a loaded freight car under federal control rose 8.5% compared with that in 1917 and 17.2% compared with that in 1916. On the other hand, the average length of a train declined

TABLE 3.1 Railroad Operating Statistics for U.S. during World War I

Item	1916	1917	1918
Revenue ton-miles for all line-haul railroads (10^6)	366,173	398,263	408,778
Average length of haul per ton of freight (mi)	277.98	288.18	296.89
Average net tons per train	618	657	689
Average net tons per loaded freight car	25.0	27.0	29.3
Average cars per train (excluding caboose)	35.3	34.7	34.7

Source: Ref. 5.

slightly between 1916 and 1917 and remained the same between 1917 and 1918. Given the circumstances under which they operated, the railroads acting on their own through the Railroads' War Board had some remarkable accomplishments in 1917. The effect of federal control was to provide much-needed coordination, not only among the various railroads but also among the various governmental procurement agencies.

Before the United States entered the war, the railroads had been having trouble generating enough capital to expand their rolling stock. They had ordered 3,400 new locomotives, but the U.S. government postponed delivery in 1917 so that 3,600 locomotives could be manufactured and sent overseas.[4] Consequently, the railroads had to handle the increased traffic with existing equipment. Many old locomotives and freight cars were driven beyond their limits. Seldom was there any opportunity to make running repairs. Existing maintenance facilities tended to be outmoded or inadequate because of neglect and lack of investment capital. Many railroad shop workers and mechanics were lost either to the Army or to better-paying jobs in the war industries.

After the U.S. government took possession of the railroads, several measures were taken to increase the supply of locomotives. From the War Department, the Railroad Administration leased 200 locomotives built for Russia and 135 light locomotives that had been intended for France. The ban on the 3,400 previously ordered

locomotives was lifted, and 1,930 locomotives were ordered. Disregarding ownership, the Railroad Administration shifted 215 locomotives from railroad companies with less urgent needs to those (mainly eastern) roads most in need of additional equipment to ease congestion.[4]

Steps were also taken to alleviate the maintenance problem. The Railroad Administration induced the mechanics to agree to work longer hours by promising to adjust their wages as soon as possible to be more competitive with the wages being paid by the war industries. The result was a 16% increase in the number of shop hours. An effort was made to ensure that railroad mechanics were not drafted into the Army until they were urgently needed. Because some railroads had poor maintenance facilities, all railroad shops were unified. Locomotives requiring heavy maintenance were taken to the nearest suitable facility regardless of railroad ownership. To relieve the shortages of materials and supplies for repairing locomotives and freight cars, efforts were undertaken to prevent usable material from being sold as scrap. Additional reclamation plants were established, and old material was repaired for reuse whenever possible.[4]

Procuring new equipment was an especially difficult problem. The war spawned a great demand for the kinds of materials needed to manufacture locomotives and freight cars. Labor was scarce in the locomotive- and car-building shops. Even more troublesome was the lack of standardization of rail equipment. The various railroad companies had developed a wide variety of types of locomotives and freight cars. To overcome the latter problem, the Railroad Administration, after consulting with some of the leading builders of locomotives and cars and the heads of the mechanical departments of many of the railroads, developed specifications for seven classes of locomotives, each subdivided into light and heavy types, and five classes of freight cars. By standardizing the equipment, the speed of production increased by as much as 50%. To alleviate the problem of a shortage of materials, wood was partially substituted for steel in gondola cars. Approximately 1,930 locomotives and 100,000 freight cars were ordered.[4]

Allocating the new equipment proved to be a vexing task. The basis for allocation was the comparative need of each railroad for new equipment, with consideration given to the volume and nature of the traffic. Nevertheless, individual companies complained that too much equipment was allocated to them, that the equipment was unsuited to their needs, and that the government should pay for the equipment since it was only needed because of the war. The Railroad Administration generally disregarded these objections, although it did make some adjustments in the allocations whenever it was clear that too much equipment had been given to a particular railroad.

Table 3.2 provides some statistics on the supply of rail equipment during World War I. The number of locomotives operated by the Class I carriers increased less than 1% between 1916 and 1917 and only 3.2% between 1917 and 1918. The tractive effort of the average locomotive also increased each year, continuing a previous trend. The number of freight cars owned by Class I railroads rose only 2.2% in 1917 compared with the 1916 level and only 1.0% in 1918 over the previous year. The aggregate capacity of freight cars, however, rose at a slightly higher rate because of the steady increase in the average capacity of a freight car. The percentage of freight cars out of service at any given time dropped somewhat after the United States entered the war, not because the equipment was kept in better condition but because minor maintenance was often deferred; cars were run until they could no longer be used.

TABLE 3.2 Supply of Locomotives and Freight Cars Owned by Class I Railroads during World War I

Vehicle Statistics	1916	1917	1918
Locomotives			
Number	61,332	61,890	63,889
Average tractive effort (lb)	33,188	33,932	34,995
Freight cars			
Number	2,253,233	2,302,059	2,325,673
Aggregate capacity (tons)	92,280,335	95,467,054	96,766,585
Average capacity per car (tons)	41.0	41.5	41.6
Average portion awaiting repairs (%)	6.2	5.9	5.9

Source: Ref. 5.

Control over Railroad Materials and Supplies

The railroads had to compete with the War Department, the Navy, and the Shipping Board for the limited supply of materials available. Before federal control was imposed, the railroads had special difficulty in obtaining a sufficient supply of crossties, because of the heavy demand for lumber during the war. Prices soared, and bidding wars developed between the railroads and other purchasers of lumber. After the government took over, the railroads were prohibited from purchasing crossties at prices higher than those in effect on December 31, 1917. The Forest Products Section within the Railroad Administration implemented measures to ensure that the railroads received enough crossties and lumber at reasonable prices. Each railroad was instructed to buy all of the ties that could be produced on its line regardless of its needs and not to purchase ties from other lines. The Forest Products Section stimulated the production of crossties by establishing prices duly related to the price of lumber and by an intensive campaign of solicitation. Standard specifications for crossties were developed and promulgated. An effort was made to treat all crossties with preservatives to extend their useful life. The Forest Products Section took control of all of the railroads' tie-processing plants and contracted for the entire output of all other preserving plants.

Coal for railroad use was the responsibility of the Railroad Administration's Fuel Section. The U.S. Fuel Administration, however, determined the conditions and prices under which coal was obtained by all coal users, including the railroads. This agency stopped the railroads' practice of placing a full supply of cars at mines that were under contract to provide coal for railroad use. The major problem faced by the railroads was that of obtaining coal of the proper quality.

3.3.4 Movement of Rail Passengers

Around the time of World War I, the railroads were the only major mode of intercity passenger transportation in the United States. In 1916, for example, the railroads accounted for 98% of all intercity passenger miles.[3] Thus, when the United States entered the war, the only effective way of moving the four million men conscripted into the Army was by rail. To meet the military's needs for troop transport, some civilian passenger service had to be curtailed. Many scheduled passenger trains were consolidated, and all unnecessary passenger service was eliminated.

Table 3.3 shows that the Class I railroads were able to accommodate increased numbers of passengers during the war years with fewer trains and about the same amount of equipment. The number of passengers rose 6.0% in 1917 over 1916 and another 1.7% in 1918 over 1917. The rate of increase in revenue passenger-miles was even greater -- 14.1% in 1917 and 8.1% in 1918 -- as the average length of a passenger trip rose in each of the two war years. On the other hand, the number of train-miles dropped slightly in 1917 from the number in 1916 and fell even more noticeably in 1918 after the federal government took over the railroads. Passenger-car miles rose during the first year of U.S. engagement in the war, but this indicator then dropped below its 1916 level as the government took control in 1918. The supply of passenger-carrying equipment increased by only 311 cars between 1916 and 1918.

With more passengers and fewer trains, the obvious effect of the wartime situation was an increase in passenger loading and more efficient operations. The number of passengers per train increased 14.3% between 1916 and 1917 and 17.3% between 1917 and 1918. Likewise, the number of passengers per car increased each year -- 11.2% in 1917 and 15.7% in 1918. The average length of a passenger train, including mail and baggage cars, also increased slightly as some train schedules were consolidated.

3.4 OCEAN TRANSPORTATION

Probably the most serious limiting factor affecting American military involvement in World War I was the uncertain availability of ocean transportation. When the war started in Europe in 1914, Great Britain had by far the largest merchant marine of any nation. The British fleet included 10,218 seagoing vessels of 100 gross tons or more, for an aggregate capacity of 20,831,000 gross tons. The United States, on the other hand, ranked a distant third, with only 1,296 ships having an aggregate capacity of 2,611,000 gross tons.[7] Nearly 90% of U.S. foreign trade in 1914 was carried on foreign-flag ships.[1] Compounding the problem for the United States was the growing loss of Allied and neutral shipping during the first three years of the war. Allied and neutral nations lost 319,400 gross tons of ocean-transportation capability in 1914; 1,312,216 tons in 1915; 2,305,569 tons in 1916; and 2,358,504 tons during the first four months of 1917.[7] The United States lost only 16,154 gross tons in 1915 and 14,720 tons in 1916. However, between the beginning of February and the end of April 1917, U.S. merchant marine losses jumped to 48,175 gross tons as Germany launched its intensive submarine campaign.[7] During the first three months of this campaign, the Germans sank 470 ships,

TABLE 3.3 Rail Passenger-Service Supply and Operating Statistics for the Class I Railroads during World War I

Item	1916	1917	1918
Revenue passengers (10^6)	1,006	1,067	1,085
Revenue passenger-miles (10^6)	34,586	39,477	42,677
Train-miles (10^6)	583	583	537
Passenger car-miles (10^6)	3,426	3,507	3,307
Passenger cars	43,028	43,043	43,339
Railroad-owned	35,648	35,310	35,613
Pullman Company	7,380	7,733	7,726
Average length of trip per passenger (mi)	34.4	37.0	39.3
Passengers per train	59.3	67.8	79.5
Passengers per car	15.50	17.23	19.94
Cars per train	5.88	6.02	6.16

Source: Ref. 5.

122 in a single fortnight in April. By autumn of 1917, 17 million deadweight tons of the world's ocean shipping had been lost and less than half of that had been replaced. British shipbuilding had dropped from two million gross tons in 1913 to only 630,000 gross tons in 1916. Allied and neutral nations ultimately lost 6,078,125 gross tons of merchant vessels in 1917 and 2,528,082 gross tons in 1918. U.S. merchant ships accounted for only 2.7% of the tonnage lost in 1917 and 5.6% in 1918.[7]

The entrance of the U.S. into the conflict only exacerbated the problem of ocean transportation. The United States simply did not have enough ships of its own to carry all of the troops and supplies it planned to send to Europe. In early 1917, the country only had 1,500 ships in its merchant marine, and nearly half of those ships were unsuited for foreign trade.[7] Thus, instead of immediately relieving the shipping situation, U.S. military involvement placed further strain on an already overtaxed neutral and Allied fleet.

3.4.1 Acquisition and Control of Ocean Transportation

Upon entering the war, the United States was immediately concerned with padding its own merchant marine as quickly as possible until its shipbuilding program could show some results. The primary sources of oceangoing vessels were the German ships that had been idling in American harbors since 1914 and neutral ships that were not being fully used on the Atlantic. The German vessels were quickly appropriated. Through the old law of angary, the United States also seized 87 Dutch vessels anchored in American harbors. By threatening to discontinue American exports if they did not cooperate, the United States was able to charter a substantial amount of ocean tonnage from Norway, Sweden, Denmark, and Japan.[1]

The Army, the Navy, the Food Administration, and the War Industries Board competed for the available shipping. At first, it was every agency for itself. Then, in August 1917, the Shipping Board took control over all American-flag vessels. (The Board had been established in 1916 to foster the development of a merchant marine for commercial purposes.) After August 1917, any agency needing ocean transportation had to request it through the Shipping Board.

To counter the German submarine campaign, the United States and the Allies adopted the convoy system. The convoys consisted of groups of 20 to 25 merchant ships escorted by a number of destroyers, sloops, and trawlers. The first convoy started from the Mediterranean on May 10, 1917. The system was quite successful. Before it was implemented, Allied and neutral nations were losing ships in one out of every ten voyages. During one two-week period in April 1917, one out of every four ships failed to complete its voyage. After the system was adopted, the rate of loss fell to 0.7%. Only 118 ships out of the 16,600 that traveled in convoys were lost.[7]

3.4.2 New Ship Construction

Before 1916, U.S. shipbuilding had been virtually nonexistent. Only 17 ships of 2,000 gross tons or more were built in private U.S. shipyards in 1914, and only 21 were built in 1915.[2] In 1916 the Shipping Board was founded to oversee the development of a U.S. commercial fleet, and the number of ships built increased to 46.[2] Within a week after the United States declared war on Germany, the Shipping Board formed the Emergency Fleet Corporation to construct and operate the ships needed for the war effort. Stimulated by the war, the American shipbuilding industry began a remarkable climb. In 1917, 37 steel-ship yards with 162 slipways and 24 wooden-ship yards with 72 slipways went into operation. By November 1918, there were 223 yards with 1,099 slipways, 40% of which were used to construct steel ships.[7] The United States produced 73 ships with an aggregate tonnage of 450,377 gross tons in 1917 and 257 ships with an aggregate tonnage of 1,388,300 gross tons in 1918.[2]

3.4.3 U.S. Reliance on Foreign Vessels

Despite the expansion of the U.S. shipbuilding industry, by April 1918 it was clear that the United States would not be able to transport all of its troops and their

equipment to France with the ships it had under its control. Indeed, the European Allies had been counting on American shipping for their own imports. Instead, the Europeans now had to assist the Americans.[7]

The Allied Maritime Transport Council (AMTC) was partly instrumental in obtaining ocean transportation for American troops. This organization had evolved from a conference of all the Allies in Paris in November 1917. Its principal objective was to make the most efficient and effective use of the 500,000 tons of chartered neutral ships under direct Allied control. The AMTC was able to divert some Italian passenger liners for the use of American troops.

Most of the arrangements for transporting American troops, however, were made outside of the AMTC through direct negotiations between the United States and Great Britain. Thus, of the 943,000 troops sent to France between April and July 1918, about 519,000 (55%) were transported in British-owned vessels. In August 1918, an additional 310,000 American soldiers went overseas, 103,985 in American and French vessels, 195,589 in British ships, and 10,426 in Italian passenger liners.[7]

3.5 SUMMARY

Despite an awkward start, the United States was finally able to organize its transportation system in time to effect a relatively quick end to the war. Indeed, U.S. involvement in World War I led to considerable improvement in segments of the domestic transportation system. Because of government control, the railroads were in somewhat better financial and physical shape after the war than before. The war also revitalized a dormant U.S. merchant marine and shipbuilding industry.

The war taught several lessons about the functioning of a multimodal transportation system during a national emergency. First, it revealed the importance of unification within modes and coordination between modes. The U.S. government found that it could not rely solely on the voluntary efforts of the individual railroads to achieve the necessary unification and coordination of the railway system, especially in a regulatory environment that prohibited most forms of cooperation among the carriers. The government also learned not to grant priorities for shipping. More than any other factor, the unrestrained and uncoordinated priority system used during the country's first year in the war contributed to the congestion of the ports and the railway system. As did the war against Spain in 1898, World War I showed once again how easily ports and other terminals can become blocked when the flow of freight coming in is not coordinated with the flow of freight going out. The government learned the importance of linking the movement of freight to the ports with the capacity of the port facilities and, particularly, the availability of ocean transportation. The latter proved to be the principal factor limiting the U.S. military effort in the war. Most of the lessons taught by World War I were remembered and subsequently applied during the early stages of involvement in World War II.

4 WORLD WAR II

For the United States, World War II surpassed World War I by virtually every measure. The U.S. was militarily involved in World War I for only the last 20 months of a war that lasted a little over four years. Its military involvement in World War II covered the final three years and nine months of a war that lasted six years. In World War I, the major theater was western Europe, and U.S. forces were concentrated in France. In World War II, the United States had to battle enemies on both sides of the globe. The major theaters included all of Europe, the North Atlantic, the coastal areas of North Africa, eastern and southeastern Asia, Indonesia, and the islands of the Central and Southwest Pacific. In World War I, the United States sent slightly over two million troops to the war zones. During World War II, roughly 15 million men and women served in the U.S. armed forces.

Despite the much wider scale and scope of the Second World War, the U.S. transportation system functioned well, with no major crises. Certainly the system was strained throughout the war, but constant supervision and coordination kept the traffic flowing steadily if not swiftly. This performance contrasted sharply with that in World War I, when many parts of the system were all but paralyzed and the system as a whole was near collapse before the federal government finally took control.

4.1 NATURE OF MOBILIZATION

4.1.1 Preparation for War

As in the previous war, the United States was a late entrant into World War II. The war officially began on September 1, 1939, when Germany invaded Poland. The United States did not join the hostilities until December 8, 1941, the day after the attack on Pearl Harbor, when the U.S. government declared war on Japan. This was followed six days later by a declaration of war against Germany and Italy. Thus, the U.S. government had over two years in which to prepare the country for war. In fact, the United States had more time than that, since the threatening situation in Europe and the Far East had been developing throughout much of the previous decade. Nevertheless, when the nation entered the war in December 1941, it was not as well prepared as it could have been, either militarily or industrially.

The United States' lack of total preparedness was not due to a lack of planning. The War Department had been developing mobilization plans throughout the 1920s and 1930s. These plans, based largely on the military's experience in World War I, were often unfeasible and unrealistic, calling for a mobilization of troops completely out of synchronization with the country's industrial capability to support it. The plans included very little contribution from civilian leaders. Most significant, the military planners did not envision any conflict of the magnitude of World War II.

The principal reason behind the absence of early preparation for war was the country's general desire to stay out of a war at all costs. The behavior of Japan,

Germany, and Italy during the 1930's had little effect in that period on the military budget of the United States. Congress never appropriated funds to build a small reserve of modern arms and special equipment. Efforts to get Congress to pass legislation establishing a mechanism for mobilizing industry and the military in the event of a national emergency consistently failed. Instead, Congress enacted a series of neutrality laws during the Depression years, seeking to keep the nation out of conflicts in other parts of the world. During this period, an intense debate was going on between the isolationists and the interventionists, but the general mood of the public was against the kind of strong economic controls or central direction needed for any major industrial mobilization effort.[1]

Only after the fall of France in the spring of 1940 did some members of Congress begin to look more closely at the United States' state of preparedness. They were alarmed at the obsolescence, the inadequacy, and the vulnerability of the nation's defenses. From this investigation and the sudden realization that the situation in Europe posed a serious threat to the United States came the impetus for the rearmament program that began in June 1940. Total funding for the War Department, which had been $496 million in fiscal year (FY) 1939 and $1.1 billion in FY 1940, increased to nearly $13 billion in FY 1941 and $22.25 billion during the first half of FY 1942.[1] This effort to rearm the nation was not enough to place the military in a position of full readiness, but it nevertheless made a crucial difference in the American war effort.

4.1.2 Full Mobilization

True to its tradition, the U.S. government emphasized manpower mobilization over weapons and equipment. In September 1940, Congress passed the first peacetime military-draft law in American history. By December 1940, the Army consisted of 600,000 officers and men. By June 1941, it had grown to 1,460,000.[1] These troops were mobilized before they could be equipped. Many of them had to train with sticks instead of guns and practice maneuvers with trucks instead of tanks.[1]

Thus, when the United States entered the war, it found itself in the same predicament it had been in at the start of World War I, with its facilities for producing munitions and other military equipment woefully inadequate. The national response was the same as it had been in 1917 -- a rapid, all-out effort to convert existing civilian plants for war production, expand existing private munitions plants and government arsenals, and construct new private and government-owned war production facilities.

4.2 GOVERNMENT CONTROL OVER TRANSPORTATION

4.2.1 Nature of Control

The manner in which the U.S. government controlled transportation during World War II differed sharply from that of World War I. In the preceding war, the government actually had taken over the operation of almost every mode of transportation in the country. The principal operating officers of the railroad companies, steamship lines, and

tug and barge operations had to sever their connections with these enterprises and become exclusive agents or representatives of the federal government. In World War II, the government did not take possession of the railroads or any of the other carriers (except in a few instances where transport operations were affected by strikes or were threatened by labor difficulties); instead, it left the operation of the transportation system in the hands of private management and exercised supervisory control over that management. Certainly, the government did impose some restrictions on operations, sometimes explicitly and sometimes implicitly (e.g., rationing). Nevertheless, in many cases transportation problems were overcome through cooperative arrangements and persuasion rather than through tight controls.

The principal agencies of government directly concerned with transportation were the Office of Defense Transportation (ODT) and the Interstate Commerce Commission (ICC).

4.2.2 Office of Defense Transportation

World War I graphically demonstrated the importance of centralized control and intermodal as well as intramodal coordination. In World War II, these control and coordination functions were assigned to the Office of Defense Transportation. The ODT, created by Executive Order 8989 on December 18, 1941, was given responsibility for the following:

- Coordinating the transportation policies and practices of the various federal agencies and private carriers and transportation groups,
- Compiling and analyzing information on the estimated demand for existing transportation equipment and facilities,
- Determining the adequacy of existing transportation facilities,
- Developing measures to get the most out of available transportation facilities and equipment,
- Advising the Supply Priorities and Allocation Board on the estimated requirements and recommended allocation of materials and equipment,
- Coordinating and directing domestic traffic movements to prevent congestion,
- Coordinating domestic traffic movements with ocean shipping to avoid congestion at the ports,
- Surveying and ascertaining current and anticipated needs for storage and warehousing,

- Representing the defense interests of the government in negotiating rates with the carriers, and

- Representing the transportation industry before the War Production Board in obtaining scarce materials and supplies for the carriers.[6]

Although it instituted its own control measures when necessary, the ODT mainly relied on the cooperation of the transportation industry to achieve its objectives. Many industry officials served as agents of the ODT and administered its orders. The agency's policymaking personnel were recruited largely from industry. More than 6,000 Industry Advisory Committees were formed, composed of representatives from all types of carriers and shipping firms. These committees assisted the ODT in framing its orders and resolving various transportation problems as they arose.

4.2.3 Interstate Commerce Commission

As the administrator of the Interstate Commerce Act, the ICC regulates the interstate operations of all the common carriers. During World War I, the ICC was also given extraordinary powers over the movement of railroad traffic during times of equipment shortages, congestion, or other transportation emergencies. In 1942, these emergency powers were extended to cover motor carriers as well.

The ICC in 1917 had created the Bureau of Service to administer its emergency powers. The Bureau had the authority to suspend the operation of any or all car service rules, develop new car service rules without regard to car ownership, require joint or common use of terminals, and assign priorities in transportation, embargoes, or movement of traffic.[6] Some of the functions of the ODT and the ICC Bureau of Service overlapped. Indeed, the activities of the two agencies sometimes conflicted. Nevertheless, the ODT worked very closely with the Bureau of Service; quite often, the ODT would administer the orders of the ICC and vice versa.

4.2.4 Other Agencies Concerned with Transportation

A number of other government agencies were created in World War II to manage various aspects of the war effort. Although these agencies had no direct authority over the transportation system, the measures they took within their own areas of responsibility often affected transportation operations. The ODT and the ICC Bureau of Service had to work very closely with these agencies.

The dominant entity was the War Production Board (WPB), which had authority over the allocation, production, transmission, procurement, and transportation of materials, articles, power, fuel, and other commodities.[6] By determining the priorities in production, the WPB in effect also determined the priorities in shipping. In establishing these priorities, the WPB acted through the ODT. The WPB also exerted considerable influence over transportation through its power to allocate tires, rubber, gasoline, and other scarce materials needed by the carriers.

The Office of Price Administration (OPA) was responsible for controlling inflation during the war. Its most direct influence on transportation came from its role as administrator of the nation's tire- and gasoline-rationing program. In this capacity it carried out the ODT's policies regarding motor transport services. Although the OPA had authority to fix prices, it had no control over the rates charged by for-hire carriers. It could, however, influence these rates by intervening in rate cases before the ICC.

The Petroleum Administration for War (PAW) was responsible for assuring an adequate supply of petroleum. It formulated plans for producing, distributing, and transporting petroleum and made allocations under the direction of the WPB. The PAW influenced the construction and extension of petroleum pipelines and prescribed the kinds, the quantity, and the direction of flow of petroleum through the pipelines.

The Solid Fuels Administration for War (SFAW) played a major role in the transportation of coal. It prepared annual coal-production programs that enabled the ODT and the coal carriers to plan well in advance on ways to handle the load. The SFAW established priorities among various classes of coal users, fixing the quantities of coal for each class. Its orders often included instructions on how the coal was to be shipped.

The War Manpower Commission within the Office for Emergency Management was responsible for the nation's human resources. It handled problems concerning the effects of the military draft on the supply of labor, including transportation labor.

The War Food Administration (WFA) within the Department of Agriculture was responsible for ensuring the adequate supply and efficient distribution of food to meet essential needs. The WFA had the power to set priorities in the movement of food in case of a shortage of transportation services. This responsibility led to some serious conflicts between the WFA and the ODT.

The Office of War Mobilization, created May 27, 1943, coordinated the activities of the various federal agencies and departments engaged in or concerned with the production, procurement, distribution, or transportation of military or civilian supplies. It resolved a number of interagency disputes and issued orders diverting transportation facilities from nonessential uses.

4.3 MILITARY USE OF DOMESTIC INLAND TRANSPORTATION

As the generator of large volumes of passenger and freight traffic during the war, the U.S. military played an important role in the operation of the domestic transportation system. The Transportation Corps, created in July 1942 to centralize and control all military transportation activities, worked closely with the carriers and the ODT to ensure that the Army's transportation needs were met expeditiously. The Corps was intimately involved, especially through its Division of Traffic Control, in the formulation of transportation control measures and assisted in the execution of ODT orders. The following discussion indicates the relative magnitude of military traffic during the war and how this traffic was controlled.

4.3.1 Movement of Troops

Between December 1941 and August 1945, the Division of Traffic Control routed 33,678,000 military passengers traveling in groups of 40 or more. Of this total, 32,881,000 (97.6%) traveled by rail; the remainder were transported by bus. Military passenger traffic reached a peak in April 1943, when 1,059,000 troops were transported in organized groups of 40 or more, again primarily by rail. Troop movements within the United States then gradually declined to a low of 527,000 in April 1945. However, with the influx of soldiers returning from Europe, the volume reached a new peak of 1,205,000 military passengers in August 1945. Of this total, 1,174,000 traveled by rail, the rest by bus.[6]

To move an infantry division and its equipment in 1942 required 63 trains, consisting of 442 tourist sleeping cars, 48 standard sleepers, 89 baggage cars, 90 kitchen cars, 1,124 flat cars, and 89 boxcars. To transport an armored division required 69 trains with a total of 2,221 cars.[1]

Beginning in June 1942, the railroads held blocks of space in reserve for the use of the Army and certain other government agencies. During the spring of 1943, when military passenger traffic was at its peak, 50% of the sleeping cars and 30% of the coaches were reserved for the movement of troops.[6] Throughout 1943, an average of 28,815 passenger and freight cars a month were used in special troop trains or as special cars attached to regular trains to haul Army troops and their equipment.[1] In addition, the War Department commissioned the building of 1,200 special troop sleepers and 400 special troop kitchen cars.[6]

The Division of Traffic Control, under the Army's Office of the Chief of Transportation, was responsible for routing all organized troop movements within the United States. Each year, joint agreements were arranged between the military and the regional passenger associations. Starting in 1943, the Army established reservation bureaus at the principal railway centers. Eventually, 92 such centers were set up.[6]

Late in the war, extraordinary measures were instituted to accommodate the movement of wounded troops and others returning from Europe. In June 1944, the ICC issued a Service Order requiring railroads to cancel reservations and passenger-train service when necessary and to use the equipment instead to transport wounded troops and their attendants. On July 15, 1945, the ODT issued a General Order requiring the railroads and the Pullman Company to divert all sleeping cars operating between points less than 450 miles apart from civilian to military use. The cars were needed to transport troops returning from Europe, particularly those being redeployed for the conflict in the Far East. Two days later, the ODT issued another General Order placing all passenger, baggage, and express cars at the disposal of the military as needed.[6]

4.3.2 Movement of Military Freight

Between December 1941 and August 1945, the War Department shipped 324,891,000 tons of freight within the United States. Of this total, 294,121,000 tons (90.5%) were shipped by rail. War Department rail traffic accounted for 5.1% of the

total ton-miles of rail freight in 1942 and 12.5% of the total ton-miles of rail freight in June 1945. Motor carriers handled 8.2% of the War Department's tonnage between December 1941 and August 1945, while carriers on the inland waterway system transported the remaining 1.3%.[6] The motor carriers were used primarily for short hauls, and barges were used to transport low-priority bulk goods.

Much of the military's cargo was bound for the ports. Between December 1941 and August 1945, the Army shipped 94 million tons of freight abroad.[6] Consequently, the War Department played a major role in controlling the flow of freight to the ports.

Having learned from the unhappy experiences of World War I, the Office of the Quartermaster General, and later the Transportation Corps, constructed holding and reconsignment points at the following locations: Vorheesville, New York; Elmira, New York; Marietta, Pennsylvania; Richmond, Virginia; Shreveport, Louisiana; Montgomery, Alabama; Yermo, California; Pasco, Washington; and Auburn, Washington.[6] Operated by the War Department, the holding and reconsignment points served as reservoirs of freight destined to the ports. During the war, these points received and stored about 300,000 carloads of Army and Lend-Lease freight. They were supplemented by railroad open-storage yards owned and operated by the railroads under close liaison with the Army. The yards received and stored an additional 100,000 carloads of Army and Lend-Lease freight during the war.[6] Together, the holding and reconsignment points and the railroad open-storage yards helped to keep the ports free of congestion. Freight cars were seldom held at the ports for longer than ten days.[1]

The War Department assisted the ODT in the latter's continuous campaign against LCL loading. The Army established consolidation stations where LCL lots were brought together to be shipped in full carloads.

4.4 TRANSPORTATION OF FREIGHT WITHIN THE UNITED STATES

4.4.1 Rail Transportation

Wartime Traffic

During World War II, the railroads hauled the highest volumes of freight ever in their history up to that time. As Table 4.1 shows, the average annual revenue tonnage carried by the railroads during the four years the U.S. was engaged in the war was approximately 24% higher than it was during World War I. Moreover, the average annual number of revenue ton-miles on the railroads was 73% higher in 1942-1945 than in 1917-1918, indicating that the average length of haul during World War II was much higher than in World War I. Before World War II, the most freight ever carried in one year by the Class I, II, and III line-haul railroads was 2.58 billion tons in 1929. In that year, the railroads transported what was then a record 450 billion ton-miles of freight.

More significant than the record volumes of rail freight was the record rate at which these volumes increased. Compared with 1940 values, revenue ton-miles of rail

TABLE 4.1 Freight Traffic on Class I, II, and III Line-Haul Railroads during World Wars I and II

Year	Revenue Tons Originated (10^6)	Revenue Tons Carried (10^6)	Revenue Ton-Miles (10^6)	Portion of Total Ton-Miles by Rail (%)
1917	1,382	2,453	398,263	N.A.[a]
1918	1,377	2,477	408,778	N.A.
1939	955	1,730	335,375	64.26
1940	1,069	1,947	375,369	63.36
1941	1,296	2,405	477,576	64.72
1942	1,498	2,946	640,992	71.08
1943	1,557	3,158	730,132	72.79
1944	1,565	3,156	740,586	70.19
1945	1,493	2,962	684,148	68.90

Sources: Refs. 5 and 6.

[a]N.A. = not available.

freight increased 27.2% in 1941, 70.8% in 1942, 94.5% in 1943, 97.3% in 1944, and 82.3% in 1945. The average annual rate of increase in revenue ton-miles between 1940 and 1943 was 31.5%.

On the railroads operating west of the Mississippi, the growth in traffic during the war was even more pronounced. The average monthly ton-miles of freight on these roads rose from 17.5 million in 1940 to 33.75 million in 1945, an increase of 91.6%. Average monthly trainloads in the West increased 23%, from 2,075 tons in 1940 to 2,545 tons in 1945. Average monthly ton-miles per train-hour on the western railroads jumped from 272,329,000 in 1940 to 509,821,000 in 1945, an increase of 87%. Empty car-miles climbed 43%, rising from 164,051,000 in 1940 to 234,960,000 in 1945. Total car-miles per month increased by 304,347,000, or 69%, between the two years.[6] These statistics reflect the sudden strategic importance of the western railroads during World War II. During World War I, virtually all export freight flowed to the eastern ports. In World War II, however, with major theaters on both sides of the globe, there was a sudden need to ship large quantities of materials to the west-coast ports. In addition, the U.S. government for strategic reasons established numerous war industries in the west, often despite poor access to transportation. These two factors, together with the destruction of coastal and intercoastal water transportation by enemy submarines, resulted in a surge of traffic on the western rail lines.

Thus, in World War II as in World War I, the railroads became the workhorse of the transportation system. Table 4.1 shows not only that their share of the total ton-miles of intercity freight was the highest of all modes, but also that this share increased during the early years of U.S. involvement in the war, reversing a previous trend.

Infrastructure and Rolling Stock

The railroads were able to handle the record volumes of freight and the longer hauls with less trackage and less equipment than they had had during World War I.

Trackage. Table 4.2 shows that the Class I, II, and III line-haul railroads owned 24,355 fewer miles of road and operated 11,861 fewer miles of main-line track in 1942 than in 1918. Moreover, the miles of track operated continued to decline during the war.

The decrease in trackage was offset by an increase in the load-bearing capacity of the rail and by other capital improvements made by the railroads between World Wars I and II. In 1920, the average weight per yard of main-line track operated by Class I railroads was 82.2 lb, and only 13.5% of the total Class I railroad main-line trackage weighed over 100 lb/yd. By 1940, the average weight per yard had increased to 95.3 lb, and 41.6% of all Class I railroad main-line track weighed 100 lb/yd or more. The average weight of rail continued to increase during the war years to 96.0 lb/yd in 1941, 96.7 in 1942, 97.3 in 1943, 98.1 in 1944, and 98.9 in 1945. During the last year of the war, 43.5% of main-line rail weighed 100 lb/yd or more.[5]

TABLE 4.2 Main-Line Trackage Operated by Class I, II, and III Line-Haul Railroads during World Wars I and II

Year	Miles of Road Owned	Miles of Main Track Operated[a]	Miles of Track under CTC[b]
1917	253,626	294,771	N.A.[c]
1918	253,529	294,735	N.A.
1939	235,064	288,367	2,143
1940	233,670	287,113	2,407
1941	231,971	285,429	2,703
1942	229,174	282,874	3,592
1943	227,999	281,838	4,747
1944	227,335	281,393	6,109
1945	226,696	280,544	7,384

[a]Includes some duplication of mileage operated under trackage rights by two or more railroads.

[b]CTC = centralized traffic control.

[c]N.A. = not available.

Source: Ref. 5.

Between 1920 and 1940 (inclusive), the Class I railroads installed over 27.5 million long tons of new rail. Most of this rail was laid before the Great Depression. Between 1941 and 1945, the Class I railroads replaced some of the existing track with 6.8 million long tons of rail.[5]

Centralized Traffic Control. Contributing significantly to the railroads' ability to handle more traffic with less trackage and equipment was the greatly expanded use of centralized traffic control (CTC), which was especially crucial to the western and southern roads. These lines had long sections of single track on important through routes. Double tracking was not feasible because of insufficient time and shortages of rails, crossties, and other materials. In many cases, CTC was the only practical alternative.

The crucial Union Pacific line between Salt Lake City and Los Angeles provides an example of the effect that CTC had on railroad operations. Centralized traffic control was installed on 171 miles of this line between Yermo, California, and Las Vegas, Nevada, in June 1943. As a result, the congestion that had been plaguing the line since the start of the war was eliminated. The average time of all freight trains was reduced by three hours. Whereas freight trains had been taking 13 to 16 hours to cover the 171-mile section, under CTC they could make the run in ten hours and sometimes in only seven or eight hours. Because the line operated more efficiently, the number of helper locomotives needed for the steep grades was reduced from 14 to seven.[6]

Table 4.2 shows that the number of miles of track under CTC more than tripled between 1940 and 1945. Altogether, CTC was installed on 99 strategic sections of track during the war.[6] Among the more important installations (besides the one mentioned above) were the Santa Fe line between Los Angeles and San Diego, California; the Santa Fe line between Behm and Vaughn, New Mexico; and the Norfolk and Western coal-carrying line between Roanoke, Virginia, and Hagerstown, Maryland. The Norfolk and Western line became especially crucial after German submarines stopped virtually all coastal water transportation of coal to the Northeast.

Locomotives. Table 4.3 shows that the railroads started World War II with over 23,000 fewer locomotives than they had possessed at the end of World War I. In fact, the number of locomotives had been steadily declining since 1924. This trend was reversed during World War II. The yearly increase in the number of locomotives between 1941 and 1944 was partly due to a heavier infusion of new equipment. The 632 new locomotives installed in 1941 constituted the largest number since 858 were added in 1930.[5] The increase in the locomotive inventory was also due to longer retention of older equipment. The railroads made special efforts to keep all locomotives in operating condition. Table 4.3 shows a considerable drop in the average percentage of locomotives out for repairs between 1940 and 1942.

The decline in the number of locomotives between the two World Wars was offset by an increase in tractive power. The average steam locomotive in 1918 had a tractive power of 34,995 lb. By contrast, the average steam locomotive in 1941 had a tractive

TABLE 4.3 Number, Tractive Power, and Condition of Locomotives during World Wars I and II

Year	Number			Aggregate Tractive Power (10^3 lb)[a]	Portion Awaiting Repairs (%)[a]
	All Railroads	Class I Railroads	New Locomotives[a]		
1917	66,070	61,890	N.A.[b]	2,087,950[c]	N.A.
1918	67,936	63,889	N.A.	2,223,246[c]	N.A.
1939	45,172	42,511	298	2,119,032[d]	25.7
1940	44,333	41,721	421	2,130,475	21.8
1941	44,375	41,771	632	2,147,022	17.3
1942	44,671	42,033	716	2,186,038	11.7
1943	45,406	42,731	891	2,250,304	10.6
1944	46,305	43,612	1,245	2,317,089	11.0
1945	46,253	43,530	901	2,329,074	12.1

[a]Class I railroads only.

[b]N.A. = not available.

[c]Does not include electric and diesel locomotives.

[d]Does not include diesel locomotives.

Source: Ref. 5.

power of 51,217 lb, 46% higher than in 1918.[5] Both aggregate and average tractive power continued to rise during the war.

Freight Cars. The supply of freight cars owned by the Class I carriers had been dwindling since 1925. By 1941, the Class I railroads had 27% fewer cars and 11.5% less freight-carrying capacity than in 1918. As Table 4.4 shows, this trend was also reversed during World War II. Between 1939 and 1944, the supply of freight cars increased 5.4% for all railroads and 7.2% for the Class I carriers. This modest increase was mostly due to longer retention of older equipment. The influx of new equipment was never enough to overcome the chronic car shortages. As in World War I, the railroads had to drive older cars beyond normal service life. The last column in Table 4.4 shows that one of the results of the railroads' efforts was a sharp reduction in the average percentage of cars awaiting or undergoing repairs.

TABLE 4.4 Number, Capacity, and Condition of Rail Freight Cars during World Wars I and II

Year	Number[a]			Aggregate Capacity (tons)[c]	Average Capacity per Car (tons)[c]	Portion Awaiting Repairs (%)[c]
	All Railroads	Class I Railroads	New Cars[b]			
1917	2,379,472	2,302,059	N.A.[d]	95,467,054	41.5	5.9
1918	2,397,943	2,325,673	N.A.	96,766,585	41.6	5.9
1939	1,961,705	1,650,031	24,528	82,001,557	49.7	12.8
1940	1,965,385	1,653,663	65,545	82,722,361	50.0	8.8
1941	2,014,453	1,703,304	80,502	85,682,497	50.3	5.4
1942	2,047,954	1,745,495	63,009	88,186,516	50.5	3.2
1943	2,057,212	1,756,343	28,708	88,967,614	50.7	2.7
1944	2,067,948	1,769,578	40,392	89,960,375	50.8	2.7
1945	2,055,182	1,760,297	38,987	89,872,361	51.1	3.5

[a]The figures shown under "All Railroads" include railroad-owned freight cars as well as private-line cars, except for 1917 and 1918; data on the number of private-line cars for those two years are not available. The figures shown under "Class I Railroads" do not include cars of railroad-owned refrigerator-car lines.

[b]The figures include new cars owned by Class I railroads and new cars owned by railroad-owned refrigerator-car lines.

[c]Class I railroads only.

[d]N.A. = not available.

Source: Ref. 5.

Control Measures

The ODT's program of public control and supervision of the privately owned and operated railroads consisted of three major components: the Traffic Channels Plan, control over routing and train operations, and heavier loading of cars.

Traffic Channels Plan. The primary purpose of the Traffic Channels Plan was to gather daily information on the flow of traffic on the entire railway system. This information showed which routes and terminals were threatened with congestion and which routes were operating under capacity. With these data, the ODT and the railroads could detect potential bottlenecks and other problems in advance and take preventive action, such as rerouting or diverting traffic.

Under the Plan, each of the 121 Class I railroads filed a daily operating report with ODT headquarters in Washington, D.C. The reports contained the following information:

- Freight trains dispatched,
- Freight trains held out of yard one hour or more,
- Loaded cars received from connecting divisions and other lines,
- Cars loaded on line,
- Total receipts,
- Loaded cars waiting to be delivered or forwarded,
- Total loaded cars delivered,
- Loaded cars delivered to connecting divisions and other lines,
- Loaded cars received at connections with other railroads,
- Loaded cars delivered to connections with other railroads,
- Total loaded and empty cars dispatched by direction, and
- Total loaded and empty cars waiting to be moved by direction.[6]

These data were analyzed at ODT headquarters, and the results were represented on a traffic-channels map. The map, which showed all the major carriers, terminals, and gateways, was divided into three latitudinal and seven longitudinal channels to form 21 numbered zones. Areas where congestion was likely to occur were shown in color. The map was revised daily to indicate current operating conditions on the railway network.

The railroads disliked assembling and telegraphing all of this information on a daily basis. In fact, they were not required to do so. The Traffic Channels Plan was established through a cooperative agreement between the ODT and the Association of American Railroads (AAR), the organization that serves the common interests of the principal railroads of the United States, Canada, and Mexico. Nevertheless, all of the Class I carriers complied.

The Traffic Channels Plan was instituted on April 7, 1942. At first, all 121 Class I railroads submitted daily operating reports. The number of railroads reporting was subsequently reduced to 108 and then, by February 1943, to 70. Those reporting were primarily roads subject to frequent congestion and roads that transported freight over long distances through important gateways and terminals. By the end of 1944, only the nine transcontinental roads reported on a daily basis.[6]

Traffic Diversion and Rerouting. The war distorted many of the normal patterns of rail transportation. The western and southern railroads especially felt the effects of this distortion. The U.S. government located many military installations and munitions plants in western areas with limited or inadequate access to rail service, and this policy resulted in new and more circuitous routes and longer hauls. The war across the Pacific reversed the normal pattern of flows to and from the west-coast ports. In peacetime, these ports primarily received imported goods. The dominant flow of rail traffic, therefore, was eastward, away from the ports. After the attack on Pearl Harbor, the dominant flow was westward, toward the ports.

Southern railroads were affected by the damage done to coastal shipping by German submarines. Normally, a significant quantity of coal was transported by rail to Hampton Roads in Virginia, where it was transshipped by ocean vessels to the Northeast. During the early years of U.S. involvement in the war, this coal had to be shipped all the way north by rail.

Another problem at the start of the war was the uneven distribution of traffic on the transcontinental lines. While the central and southern roads were overloaded, the northern lines were underused.

The ODT and the ICC undertook joint efforts to deal with these and other situations affecting the routing of rail traffic. The two agencies appointed a common agent, W.F. Kirk of the Missouri Pacific Railway, and (under ICC Service Order No. 99) gave this agent the power to reroute and divert traffic among the transcontinental lines. Under Kirk's direction, 316 rerouting and diversion orders were issued. Of the 7,061,900 loaded cars that moved through the important gateways, 335,000 were diverted or rerouted to avoid or bypass congestion.[6]

Other measures were also undertaken to expedite the movement of freight west of the Mississippi. These included eliminating circuitous routing, blocking of cars into solid trains, reducing the speed of freight trains where excessive speed impeded operations generally, discouraging competing railroads from soliciting traffic, and eliminating cross-hauling between the Salt Lake City and Ogden, Utah, gateways.[6]

Heavier Loading of Cars. At first, the ODT relied on voluntary efforts to achieve heavier loading of cars. These efforts had a positive effect, but the ODT nevertheless subsequently issued General Order No. 18, effective November 11, 1942, under which carload freight had to be loaded to the weight or space capacity of the freight car. The ICC complemented this measure by issuing Service Order No. 68, which suspended peacetime rules and practices that fostered lighter loading of cars.

LCL freight posed a more difficult problem. The ODT had issued General Order No. 1, effective May 1, 1942, setting the minimum loading of closed cars at ten tons. This order had given the carriers permission to take cooperative measures to achieve heavier loadings of merchandise freight, subject to ODT approval. For example, the railroads were permitted to alternate or stagger merchandise train schedules, exchange or pool merchandise traffic, and operate merchandise vehicles jointly. The carriers, however, out of fear of being prosecuted under antitrust laws, had taken very few steps

toward cooperative action, even though General Order No. 1 exempted them from ICC regulations prohibiting such action. The railroads also complained that the minimum-loading requirement was holding up cars in terminals, causing more frequent stops at transfer stations, aggravating congestion at transfer points, and straining the limited supply of labor at railroad terminals. The order was also said to be responsible for the accumulation of empty cars in New England.[6]

The problem was resolved through the creation of a through service for merchandise cars. Shipments consigned to the same area were consolidated so that some local transfer stations and gateways could be bypassed. When necessary, the ten-ton minimum-loading requirement was waived. Through service was primarily established for shipments between New England and distant destinations. However, arrangements were also made to establish through service for other major centers in the East and a few places in the West. The Army abetted the ODT's efforts by establishing its own consolidated car service.

The ODT and ICC issued numerous other orders designed to expedite the flow of rail traffic and maximize the use of rail equipment. These orders covered such problems as the functioning of the ports, the movement of coal, the conservation of boxcars for grain transportation, and the transportation of perishable items. These and other special rail-transport problems are discussed in Sec. 4.4.2.

Operating Averages

Table 4.5 shows several operating averages for rail freight service during the World War II period. The figures show a continuous yearly increase, up until the last year of the war, in the average length of haul, the average load of a freight train, the ton-miles of freight carried by a train per hour, the average daily distance covered by an active locomotive, and the length of a freight train. Each of these performance indicators, which had been gradually increasing before the war, declined in 1945 and continued to fall during the first full year after the war. Each one, however, took a significantly larger jump between 1941 and 1942. The one exception to this pattern was the average train speed between terminals. During the war, the average speed dropped about one mile per hour below its average level before the war. This drop was the result of ODT efforts to reduce train speeds where excessive speed was interfering with operations in general. After the war ended, train speeds began to rise again.

Table 4.6 presents several loading and operating statistics for rail freight cars. The pattern is much the same as that revealed in the previous table. The number of miles covered each day, the number of ton-miles of freight carried per day, and the average load all increased from year to year until the final year of the war, when each indicator dropped. This decline continued during the first full year after the war. Again, the largest increase in each indicator occurred during the first year of U.S. military involvement. The figures on average carloads indicate that the efforts of the railroads, the ODT, and the ICC to effect heavier car loading were largely successful. Car loading of LCL freight, in particular, nearly doubled over the prewar level, although the average weight of LCL freight per car was still less than the required minimum of ten tons.

TABLE 4.5 Operating Averages for Rail Freight Service during World War II[a]

Year	Length of Haul per Net Ton (mi)	Net Tons per Train	Net Ton-Miles per Freight-Train per Hour	Miles per Active Locomotive per Day	Cars per Train (excl. caboose)	Train Speed between Terminals (mi/h)
1939	351.21	813	13,450	104.0	48.5	16.7
1940	351.13	849	14,028	107.5	49.7	16.7
1941	368.54	915	14,930	116.4	50.3	16.5
1942	427.76	1,035	16,132	122.4	51.8	15.8
1943	469.07	1,116	16,997	124.5	52.1	15.4
1944	473.28	1,139	17,623	122.8	53.0	15.7
1945	458.14	1,129	17,482	118.4	52.2	15.7
1946	415.48	1,086	17,173	115.9	51.8	16.0

[a]All figures relate to Class I railroads only, except the statistics on length of haul per ton of freight (these statistics also include Class II and Class III carriers).

Source: Ref. 5.

4.4.2 Special Rail-Transportation Problems

Transportation of Coal and Ore

Coal, coke, ore, sand, and gravel were transported by rail in open-top hopper cars and gondolas. During the war, the railroads had to carry much larger quantities of these commodities with only a slight increase in the inventory of proper equipment. At the same time, the normal patterns of distribution were disrupted, and the new patterns that emerged often involved longer hauls.

Table 4.7 documents the growth of open-top rail car traffic during the war. The largest increases occurred in 1941 and 1942. The volume of coal continued to increase each year until the last year of the war. Shipments of coke peaked in 1943, and ore traffic reached its highest volume in 1942.

The railroads had always been the primary mover of coal and ore. Of the 460,772,000 tons of coal produced in 1940, 82.6% was loaded at the mines for shipment by rail, 7.7% was hauled by truck or wagon, and 6.4% was loaded at the mines for water transport. After German submarines closed down much of the United States' coastal shipping, the railroads had to carry coal that normally would have been transshipped by

TABLE 4.6 Freight-Car Loading and Operating Averages For Class I Railroads during World War II

Year	Daily Car-Miles per Serviceable Freight Car	Net Daily Ton-Miles per Serviceable Freight Car	Net Tons per Loaded Freight Car	Net Tons per Car of Carload Freight	Net Tons per Car of LCL Freight
1939	36.4	610	26.9	36.8	5.5[a]
1940	38.9	664	27.6	37.7	N.A.[b]
1941	43.7	795	28.5	N.A.	N.A.
1942	48.8	975	31.8	40.1	9.7[c]
1943	51.0	1,092	33.3	41.0	9.6[d]
1944	51.9	1,113	32.7	40.3	9.2[d]
1945	49.3	1,066	32.3	39.9	9.2[d]
1946	45.2	948	31.3	N.A.	N.A.

[a]Based on a study by the ICC.

[b]N.A. = not available.

[c]Between May and December, as reported by the ODT.

[d]Reported by the ODT.

Source: Refs. 5 and 6.

TABLE 4.7 Carloads of Coal, Coke, and Ore Hauled by Class I Railroads during World War II

Year	Coal	Coke	Ore	Total[a]
1939	6,082,520	413,686	1,615,036	8,111,242
1940	6,819,614	548,686	2,148,428	9,516,728
1941	7,606,315	678,841	2,682,726	10,967,882
1942	8,356,430	731,777	3,015,745	12,103,952
1943	8,507,036	751,687	2,815,572	12,074,295
1944	8,889,518	750,685	2,648,589	12,288,792
1945	8,296,208	694,707	2,474,336	11,465,251
1946	8,004,021	586,890	1,995,721	10,586,632

[a]Open-top carloads.

Source: Ref. 5.

ocean vessel to the Northeast or through the Panama Canal to the west coast. Consequently, the share of coal shipped by rail increased to 82.9% in 1942, 84.0% in 1943, and 85.1% in 1944 before dropping to 84.9% in 1945. The share of coal loaded at the mines for water transportation, on the other hand, fell to 5.8% in 1942, 5.1% in 1943 and 1944, and 4.8% in 1945.[6]

The disruption of coastal shipping by German submarines had a major effect on the patterns of coal transport. In peacetime, large quantities of coal produced in the southern Appalachian fields had moved by rail to Hampton Roads in Virginia, from there going either up the Chesapeake Bay by barge or collier or to New England by ocean vessel. When German submarines made the ocean route too risky and the U.S. government withdrew some of the tugs and colliers from the coal trade, a new all-rail route from the southern coal fields to New England was created. Rail shipments of southern coal now passed through the Potomac Yards and Hagerstown, Maryland. Alternate routes were established through Marion and Columbus, Ohio, but because of the circuity of these alternate routes, they were generally used only to avoid or to relieve congestion at the Potomac Yards. Some of the coal from the southern mines followed a rail-barge route to New York Harbor by way of the New York State Barge Canal. All-rail shipments of coal from the northern mines to New England also increased, because of the closing of the ocean route. Wnen the situation at Hampton Roads improved considerably in the summer of 1943, the traditional rail-water route to New England became available again.[6]

The disruption of coastal shipping also affected the movement of ore. In 1942 and 1943, imported ore had to be shipped solely by rail from New York; Baltimore, Maryland; and Hampton Roads to El Paso, Texas; St. Louis, Missouri; and Birmingham, Alabama. Likewise, sulfur from southern Texas was shipped by rail instead of by water to points along the Gulf of Mexico, the South Atlantic, and the North Atlantic and to ports in Canada.[6]

Another factor distorting the usual patterns of coal and ore traffic was the establishment of new war industries and military installations in the South and West. These facilities were often strategically located but difficult to reach. Coal, limestone, and ore had to be hauled over long distances and in new directions. The construction and operation of new war plants created entirely new traffic flow patterns. As a result, the railroads began hauling the following:

- Ore, limestone, and coal to new blast furnaces in Houston and Daingerfield, Texas;
- Bauxite ore from Arkansas to new Alcoa plants at Mobile, Alabama, and Baton Rouge, Louisiana;
- Iron ore from the port at Buffalo, New York, to the Mystic Iron Works in Boston;
- Ore, limestone, and coal from Utah and Nevada to a new blast furnace at Fontana, California;

- Ore, limestone, and coal to an enlarged steel plant in Provo, Utah, and pig iron from Provo to the Pacific coast;
- 500,000 tons of ore in 1942 and 900,000 tons in 1943 from Minnesota to a reopened blast furnace at Granite City, Illinois;
- Iron and steel in gondolas from Pittsburgh; Youngstown, Ohio; and Cleveland to shipbuilding plants on the Pacific coast; and
- Coal from Duluth, Minnesota, and Superior, Wisconsin, to the Seattle waterfront for transshipment to Alaska.[6]

Table 4.8 shows the number, capacity, and condition of hopper and gondola cars available during the war to meet the greater demand for transportation of minerals. The supply and aggregate capacity of cars had generally been declining since 1925. Beginning in 1940, however, the infusion of larger numbers of new cars and the longer retention of older cars produced a steady increase in the inventory and aggregate capacity of hopper and gondola cars. At the same time, the average capacity of each car also increased, continuing a long-standing trend. As the table shows, the portion of the fleet out of service for repairs dropped considerably between 1939 and 1943.

Despite the increase in the supply of open-top rail cars, measures had to be taken to adapt this supply to the increasing volumes and new patterns of traffic. Attention was focused particularly on the mines and the ports to reduce car detention and improve rates of turnaround.

TABLE 4.8 Number, Capacity, and Condition of Gondolas and Hoppers Owned by Class I Railroads during World War II

Year	Total Number of Cars	Number of New Cars	Aggregate Capacity (tons)	Average Capacity per Car (tons)	Average Portion of Cars Awaiting Repairs (%)
1939	770,430	10,927	42,912,712	55.7	15.4
1940	790,325	29,306	44,257,060	56.0	10.0
1941	810,965	30,938	45,571,048	56.2	6.2
1942	830,065	23,144	46,770,199	56.3	3.4
1943	851,898	23,929	48,066,683	56.4	2.7
1944	863,503	20,721	48,739,886	56.4	2.7
1945	858,114	14,484	48,528,673	56.6	3.6
1946	857,334	19,890	48,664,221	56.8	4.4

Source: Ref. 5.

The programs and policies of the SFAW largely determined the allocation of hopper cars to the coal mines. However, ICC and ODT agents investigated instances of undue detention and accumulation of cars and issued embargoes when necessary to prevent congestion. Representatives of the AAR, ODT, and ICC conferred to resolve major issues of policy concerning the redistribution of coal hoppers. The AAR imposed limits on the percentage of cars that could be assigned to a mine under terms of "no-billing," the practice by which railroads assigned coal hoppers to a mine for loading even though no consignees for the coal had been designated. Initially, the AAR set the limit at 75%; however, this was subsequently lowered to 50% and then to 25%.[6] Another practice that greatly slowed the loading of coal cars at the mines was the classification of coal into numerous categories according to size and heat content. By constantly importuning shippers to consolidate and reduce the number of classifications of coal, the ICC and ODT were able to increase the turnaround rate of coal cars at the mines.

Special efforts were also made at Great Lakes and tidewater ports to expedite the movement of coal hoppers and ensure a steady flow of coal. In October 1942, the U.S. government gave the Ore and Coal Exchange, established by the railroads in 1917, authority to issue embargoes against the movement of coal to Great Lakes ports whenever congestion threatened. The ICC and the Exchange pressured transshippers into reducing the number of coal classifications and consignments, thus greatly decreasing the number of switching operations and expediting the handling of the coal. The ICC and the Exchange strictly enforced the demurrage regulations and continually urged transshippers and carriers to accelerate operations. As a result of these efforts, the average net detention for all coal cars unloaded at Lake Erie ports dropped from 4.3 days in 1941 to 3.5 days in 1942 and 3.3 days in 1944.[6] Similar measures were instituted at Hampton Roads by the Hampton Roads Coal Emergency Committee, established in early 1942 by the 44 transshippers and the three railroads serving the port. Service Order No. 92 by the ICC made the Bureau Manager an ICC agent with the authority to control the movement of rail cars carrying coal for transshipment at Hampton Roads. During the months of February, March, and April of 1942, the average period of car detention had been 9.2 days. This was reduced to 6.2 days per car for the remainder of that year and 5.3 days per car by 1944.[6] The coal carriers and transshippers serving the ports at New York, Philadelphia, and Baltimore, Maryland, also organized, forming the Northern Tidewater Bituminous Coal Emergency Committee. Service Order No. 92 also made the manager of this organization an agent of the ICC. This agent was given authority over the movement of coal cars bound for ports in New York, New Jersey, Delaware, Pennsylvania, and Maryland. The agent diverted cars from lines or piers operating at capacity to those that were less crowded, placed ceilings on the number of cars each transshipper could have at the ports, pressured transshippers into reducing the number of coal classifications and consignments, and recommended embargoes to be imposed either by the AAR or the ICC when necessary. As a result of these efforts, the number of coal classifications was lowered from 750 to 583, and the average detention period of coal cars at New York Harbor was reduced to 4.9 days per car in 1943 and 1944.[6]

Transportation of Grain

The railroads and the government managed to avoid a major crisis in the transportation of coal and ore, but such a crisis did arise in the transportation of grain. There were two aspects to the problem of grain transportation. At the beginning of the war, the problem centered around a critical shortage of storage facilities. Later, the problem became one of assembling enough boxcars at the right time and in the right place to handle the seasonal harvests.

Lack of Storage Facilities. The problem of grain storage was not a direct consequence of the war. It had its origins in the large wheat crop of 1941. An unusually large percentage of that year's grain was withheld from the market, because the government loan value of grain was well above market prices. Consequently, virtually all commercial storage facilities were already at or close to capacity when the spring harvest arrived in 1942. Some temporary storage space remained available on farms and at commercial points. Nevertheless, a considerable amount of grain had to be stored on the ground in the open, exposed to wind and weather.

The railroads' immediate concern was to prevent the use of boxcars for storing grain. Consequently, the Car Service Division of the AAR issued Embargo No. 45, effective May 20, 1942, which prohibited the railroads from accepting any grain to be transported unless the shipper or consignor could guarantee that the grain had already been sold or was intended for sale. If the grain was intended for storage, the shipper or consignor had to assure the carrier that storage space had already been reserved and that the cars would be promptly unloaded and released.

Shortly thereafter, the ICC established a permit system through Service Order No. 80. Under this system, grain-permit committees were organized at specific market centers to survey grain-storage conditions and to advise ICC agents authorized to issue storage permits. The number of permits issued depended on the market's ability at any given time to unload and release boxcars with a minimum of delay. The system gave top priority to grain in greatest danger of being lost or damaged. An effort was made under the system to allocate storage facilities equitably.

The grain-storage problem eased somewhat after 1942. More grain was held on farms, and new storage facilities were built on farms and in neighboring towns. A smaller grain crop in 1943 also helped to relieve the storage problem. Attention now turned to a more persistent problem -- the supply of boxcars.

Boxcar Shortage. Several factors combined to prevent the railroads from assembling enough boxcars in advance to handle the movement of grain in 1943. First, there was an unprecedented increase in grain traffic. Much of the grain that had been stored during the previous year, causing the severe storage problem, was now being sold in the grain markets as prices rose above the government loan value. Consequently, carloads of grain and grain products on the Class I railroads went from 2,185,022 in 1942 to 2,648,308 in 1943, an increase of 21%.[6]

A second factor was the growing demand for boxcars to transport numerous other commodities, especially Army and export freight. A number of boxcars were diverted from grain transportation to move drums of kerosene from the Southwest to New England. Others were diverted to ports along the Gulf and East Florida coasts to pick up imports of ore, raw sugar, and phosphates. Many commodities that had been shipped between the coasts by way of the Panama Canal now had to be transported by rail because of enemy submarine activity. Consequently, boxcars were used to carry tin plate, iron and steel articles, canned goods, forest products, and pulp across the continent.[6]

While the demand for boxcars grew, the supply dropped sharply. Table 4.9 shows that nearly 10,000 fewer boxcars were available in 1943 than in 1942. Moreover, the number of new boxcars introduced into freight service in 1943 was only 6% of the average number of new cars installed during the preceding three years. While the percentage of boxcars out of service for repairs was considerably less than in 1939 and 1940, this was primarily because of deferred maintenance and fewer retirements of older equipment. The retirement rate in 1943 was slightly over 2%, in contrast to the normal rate of 3.5-4.0%. A shortage of materials and labor made it difficult to maintain the cars properly. As a result, many older cars were used until their wheels fell off.[6]

Further compounding the problem was the longer turnaround time for boxcars, caused by an increase in the average length of haul of boxcar freight. The increase was more pronounced for boxcars than for other types of freight cars, because the former were used more extensively for Army and transcontinental shipments. The average length of haul of a boxcar loaded with Army freight was 750 miles, compared with the general average of 495 miles in 1944.[6] Disruptions of the normal patterns of grain

TABLE 4.9 Number, Capacity, and Condition of Boxcars Owned by Class I Railroads during World War II

Year	Total Number of Cars	Number of New Cars	Aggregate Capacity (tons)	Average Capacity per Car (tons)	Average Portion of Cars Awaiting Repairs (%)
1939	704,472	12,275	31,332,565	44.5	10.7
1940	705,366	33,252	31,618,745	44.8	7.7
1941	734,020	44,807	33,196,441	45.2	4.5
1942	754,322	34,713	34,321,096	45.5	3.0
1943	744,532	2,279	33,852,636	45.5	2.6
1944	745,465	17,608	34,139,334	45.8	2.7
1945	741,946	21,111	34,265,118	46.2	3.4
1946	728,463	18,883	33,772,301	46.4	4.0

Source: Ref. 5.

transportation also increased the average length of haul and turnaround time for boxcars. Normally, the northern grain carriers shuttled boxcars between the Montana and Dakotas region and the Minneapolis and Duluth areas. During the war, northern grain was also hauled to distilleries in the East for the manufacturing of industrial alcohol and to Tennessee, Virginia, North and South Carolina, and Florida under the U.S. Department of Agriculture's feed program.[6]

The cumulative effect of all these factors was a critical shortage of boxcars during the peak harvest period in Minnesota, North and South Dakota, and Montana. In 1942, the northern grain carriers had 128,314 boxcars available for the harvest peak. In 1943, they had only 125,899. Despite this smaller number of cars, the northern railroads managed to haul 38,234 more carloads of grain during the harvest peak of 1943 than during the same period in 1942.[6] Nevertheless, this 21.4% increase in car loadings was not enough. Numerous grain elevators were blocked, and grain piled up on the ground.

The weather also played a role in 1944 and 1945. In 1944, the southwestern winter-wheat harvest was late and the northern spring harvest was early. The two periods overlapped, and extraordinary efforts were required to shift boxcars to the North. In 1945, severe winter weather in the East virtually paralyzed the grain-transport system. Buffalo, New York, the third largest interchange point in the country at the time, was especially affected. Boxcars there and at other points in the East were blocked by snow and ice and could not be returned to the western railroads. In the winter and early spring of 1945, grain once again filled all of the storage facilities and accumulated on the ground.

Numerous measures were taken to reduce boxcar detention and expedite the movement of grain. Over 10,000 possible routes were identified and banned because of their circuity (most of them had never been followed anyway). Restrictions were placed on the number of full stops for inspection and reconsignment. Backhauls for inspections were eliminated. In some cases, shipments were routed past congested holding and inspection yards directly to the point of unloading. Grain brokers were prohibited from consigning carloads of grain to destinations at which no party would be present to accept notice of the shipment's arrival or give disposition orders. Frequent reweighing of cars loaded with grain was prohibited. Grain-elevator operators were not allowed to order more cars than they were able to load or unload promptly, nor were they permitted to continue the practice of placing orders for cars for the same loading with more than one carrier. To reduce car detention, the ICC abolished average demurrage agreements and increased demurrage charges. The amount of cross-hauling by switching services was reduced. Grain was loaded and unloaded on Sundays and holidays. An effort was made to achieve heavier car loading, and minimum-weight requirements were more strictly enforced.[6]

To meet the crisis of 1945, the ICC gave the eastern railroads permission to divert or reroute traffic over any available open lines regardless of rates or the original routing instructions. In May of that year, the ICC established an embargo and permit system to control the movement of grain to points in the East. Permits were issued according to the number of boxcars available. The situation improved after the severe winter weather finally moderated, and a sufficient number of boxcars were moved to the West in time for the 1945 harvest.[6]

Transportation of Perishable Freight

Between the World Wars, the railroads' share of long-distance perishable-goods traffic had declined substantially. In 1919, 20 million tons of perishable fruit and vegetable shipments originated on the railroad system. By 1939, the railroads were hauling only 10.9 million tons of fruits and vegetables. What occurred during those twenty years was a gradual shifting of perishable-goods traffic from rail to truck transportation. In 1929, trucks transported between 12 and 16% of the perishable tonnage of fruits and vegetables moving more than 20 miles to market. By 1936, this share had risen to 44%.[6]

Like many other trends in transportation, this one was reversed during World War II. Even before the United States entered the war, the railroads began taking on a much larger volume and share of the perishable-goods movement. Fruit and vegetable shipments originating on the railroads jumped from 10.9 million tons in 1939 to 17.0 million tons in 1940 and continued to rise thereafter, to 18.2 million tons in 1941 and 21.1 million tons in 1942. Thus, fruit and vegetable shipments by rail doubled in only three years' time after 20 years of steady decline. The railroads' share of long-distance perishable-goods traffic rose from 56% in 1936 to 77.1% in 1940, 78.1% in 1941, 81.6% in 1942, 85.5% in 1943, and 84.2% in 1944.[6]

The railroads hauled fresh fruits and vegetables in refrigerated boxcars. Not surprisingly, with the decline in rail transportation of perishable goods over the years before World War II, the supply of refrigerator cars had diminished. In 1929, there were 175,545 refrigerator cars; by 1940, there were only 143,907. The supply increased by 2,412 cars in 1941 but dropped again in 1942 to 141,473. Further reductions occurred in the following years until, by 1944, the railroads had only 138,601 refrigerator cars available to handle their greatly expanded volume and share of perishable-goods traffic.[6]

Complicating matters was the fact that the railroads did not own most of the refrigerator cars. Private car lines, corporate enterprises financed by private rather than railroad capital, owned the largest number of refrigerator cars and generally rented them to either the carriers or shippers. Large shippers of perishable goods, such as packing firms, also owned a number of refrigerated boxcars. On the average, the railroads themselves owned only about 15% of the available supply. This meant that the railroads normally did not have as much control over the disposition of this type of equipment as they did over other types.

Diversified ownership also meant a lack of standardization. Refrigerator cars were often designed to meet the particular climates and needs of the areas served by the private car lines. Thus, before the war, there was very little common use of refrigerated equipment, which in turn led to a considerable amount of deadheading (making return trips without loads).

To control the distribution of refrigerator cars during the war, the ICC issued Service Order No. 95, which took effect on November 9, 1942. Under this order, the manager of the refrigerator-car section of the AAR Car Service Division was given control over the distribution and movement of refrigerator cars. This individual worked with an advisory committee composed of representatives of the refrigerator-car owners

and a representative of the ODT. Although a nationwide pool of refrigerator cars was not formed, these cars were used without regard to ownership. Empty refrigerator cars were directed to loading areas facing a shortage of refrigerated equipment. Shippers and carriers were not allowed to use refrigerator cars to haul semiperishable and nonperishable freight in areas where refrigerator-car shortages existed.

The ICC issued other orders designed to increase the efficiency of refrigerator-car operations and to reduce car detention. The Commission imposed restrictions on the amount of diversion and reconsignment, the re-icing of perishables, and the use of refrigerator cars for nonperishable traffic (except for cars returning to the Pacific coast from the East that otherwise would have been empty). The ICC also increased demurrage charges. Despite all these orders, the ICC also relied extensively on the voluntary cooperation of the railroads, shippers, and private car lines.

Transportation of Petroleum

Prior to World War II, the bulk of petroleum and petroleum products was transported by a combination of pipelines and coastal shipping. In fact, 98.5% of the daily supply of oil for the states along the Atlantic seaboard came from the southwestern oil fields, where the oil was first pumped through pipelines to terminals on the Gulf coast and then loaded into ocean tankers for the journey up the Atlantic coast.[6] When German submarines sank 50 U.S. tankers between February and May 1942 and effectively stemmed the flow of oil to the East via the ocean route, the railroads were called to the rescue.

Even before the United States entered the war, the railroads were called upon to maintain the vital flow of oil to the states along the Atlantic coast. In the spring of 1941, the U.S. government withdrew 75 tankers from the oil trade and assigned them to the British government. This left a serious shortage of tankers to meet both domestic needs and export requirements. Nearly 20,000 rail tank cars were assembled to make the 2000-mile journey from the southwestern oil fields to the eastern refineries. The average age of these cars was 18 years. Tank-car movements rose from 50 to 450 carloads daily by September and to 600 carloads daily by October 1941.[6] This was enough to fill the void left by the transferred tankers until they were returned by the British in November 1941.

The German blockade caused a more serious problem. Before it began, ocean tankers supplied the east coast with 1,268,500 barrels of crude oil per day in January 1942. By October 1942, the volume had dropped to about 100,000 bbl/d. It fell even further, to a wartime low of 73,800 bbl/d, by May 1943.[6] The U.S. tanker fleet was removed from coastal petroleum transportation and placed in convoys to provide oil to the Allied fleets and armed forces.

Work began immediately on extending the petroleum pipeline system into the East. Until this work was completed, however, the railroads had to assume the oil tankers' previous function of moving large quantities of petroleum to the Atlantic seaboard states. Over 70,000 rail tank cars were pressed into service.[6]

To control the movement of tank cars, the ODT issued General Order No. 7 in May 1942, establishing a Tank Car Section within the ODT. In general, this order required ODT permission before any loaded tank cars could be moved. In particular, it prohibited tank car hauls under 100 miles (subsequently raised to 200 miles) without ODT approval.

Beginning on August 1, 1942, rail tank cars moved in solid trains known as symbol oil trains. These consisted of 60-car trains routed in solid blocks from terminals near oil-producing centers in Louisiana, Mississippi, Texas, and Oklahoma to destinations in the East. The trains moved over a limited number of specified routes on predetermined schedules. Each train was given a symbol indicating the date of its origin, its route, and whether it was heading eastward fully loaded or returning empty. This arrangement enabled the ODT and the railroads to monitor and control continuously the movement of individual trains. The tank cars had to be loaded or unloaded within a day after their arrival at either end of the run. Trains with fewer than 30 cars were dispatched within five hours, those with 60 cars or fewer within ten hours. At first, the loading and unloading facilities and railroad trackage at the oil terminals were inadequate, but additional facilities were quickly constructed by the petroleum industry and the railroads.

Remarkable improvements were made in the speed of tank car deliveries to the east coast. Between 1939 and 1941, loaded tank cars averaged only 50 mi/d. With the introduction of the symbol oil train in the middle of 1942, the average distance covered more than doubled, to 106 mi/d per car. In 1943 and 1944, the average tank car covered 127 to 128 mi/d. Some railroads were able to achieve distances of 200 to 300 mi/d per car; however, oil-train speeds above 40 mi/h were prohibited.[6]

Several tank-car pools were also formed to expedite the movement of crude oil to eastern states. The most notable of these was the Norris City Tank Car Pool, which operated between February and November of 1943. The pool included 10,000 tank cars contributed by eight major oil companies and was intended to reduce the number of switching operations at railroad terminals. Tank-car facilities were constructed at Norris City, Illinois, to receive oil pumped from Longview, Texas, via the Big Inch pipeline. The storage tanks at Norris City could hold 1,280,000 barrels of crude oil, and 1,160 tank cars could be loaded daily. On the average, about 1,100 loaded tank cars moved out of Norris City each day on a single track in 75-car trains dispatched every 52 minutes. The daily volume of oil reached a peak of 209,000 bbl in August 1943. The Norris City Tank Car Pool saved a considerable amount of time. The average turnaround time for a tank car beginning its run in Texas was 18 days; from Norris City, the average turnaround period was only ten days. Tank-car deliveries from Norris City were suspended in November 1943 when the extension of the Big Inch pipeline to the east coast was completed.[6]

Table 4.10 shows how effectively the railroads assumed the function of the oil tankers in supplying petroleum to the eastern seaboard. In 1941, tank cars handled only 2.3% of the daily volume of oil flowing to the east coast. From that base, the percentage of the East's daily oil supply transported by rail soared to 51.3% in 1942 and 61.3% in 1943 before falling back to 37.7% in 1944 and 27.8% in 1945 as the newly constructed eastern pipelines and the ocean tankers, river and canal barges, and Great Lakes tankers began taking on a larger share of the eastward oil flow. Tank-car

TABLE 4.10 Transportation of Petroleum to the East Coast by Mode during World War II

Mode	Average Amount Transported per Day (bbl/d)				
	1941	1942	1943	1944	1945
Tankers	1,421,000	390,611	159,563	275,776	450,665
Tank cars	35,000	624,684	851,905	646,113	504,497
Pipeline	54,000	120,459	266,990	662,599	732,837
Barges and lake tankers	28,000	80,793	112,147	127,641	127,002
Total	1,538,000	1,216,547	1,390,605	1,712,129	1,815,001

Source: Ref. 8.

deliveries to the east coast rose from 98,500 bbl/d in January 1942 to 584,717 bbl/d in April of that year, after German submarines stopped virtually all coastal shipments. By September of 1942, the railroads were hauling an average of 828,425 barrels of oil a day to the eastern seaboard (approximately 70% of all the oil delivered to the east coast). Between September 1942 and March 1944, tank cars accounted for 50-75% of all petroleum transported to states along the Atlantic coast. The amount of oil transported by tank cars peaked at 982,110 bbl/d in July 1943.[6]

The railroads also played a key role in moving petroleum to the west coast. Before the war, the west coast was normally self-sufficient in oil production. Tank-car deliveries from the interior only averaged 6,200 bbl/d in 1941.[6] However, because of the war in the Pacific and the development of new war industries in the West, additional supplies of oil were needed. In 1942, tank car deliveries rose slightly, to 9,500 bbl/d. Deliveries were up even more in 1943, averaging 25,000 bbl/d. Between June 1944 and June 1945, 10,000 to 14,000 tank cars were diverted from the eastern movement to serve the west coast. As a result, by November 1944, the railroads were delivering an average of 127,000 bbl/d of oil to the Pacific seaboard. Tank-car deliveries increased to an average of 165,000 bbl/d by June 1945, with more than 17,400 tank cars involved in that movement.[6]

4.4.3 Export Traffic and U.S. Ports

Export Volumes

As Table 4.11 shows, World War II induced a tremendous growth in export traffic. In 1942, the first full year of U.S. involvement in the war, the volume of export freight in carloads was 52.8% higher than in 1940. Between 1940 and 1944, export volumes more than tripled.

The North Atlantic ports received the highest percentage of export freight during each year of the war. The volume of freight sent to these ports increased by a factor of 2.87 between 1940 and 1944 and then declined somewhat in 1945 as the war in Europe ended in the spring of that year.

Particularly significant was the huge increase in export traffic at the Pacific coast ports. In 1940, these ports accounted for only 7.3% of all carloads of export freight. During the last year of the war, they received 34.5%. Between 1940 and 1945, the annual number of carloads of export traffic shipped to the west coast increased by a factor of 14.87. This tremendous growth in export traffic along the west coast was especially significant, because these ports had been designed primarily to handle imports.

The South Atlantic and Gulf coast ports experienced the smallest increase in export traffic during the war. Nevertheless, between 1941 and 1945, carload volumes of export freight at these ports almost exactly doubled.

Freight-Car Storage Capacity

During World War II, U.S. ports had enough capacity to store a maximum of 141,605 railroad cars. The North Atlantic ports held 56.4% of this capacity, with storage

TABLE 4.11 Carloads of Freight Exported during World War II[a]

Year	North Atlantic Ports	South Atlantic and Gulf Ports	Pacific Coast Ports	All U.S. Ports
1940	373,973	182,091	43,504	599,568
1941	458,909	164,305	57,525	680,739
1942	531,874	167,826	216,235	915,935
1943	798,002	200,952	451,613	1,450,567
1944	1,071,891	231,219	602,059	1,905,169
1945	898,879	328,105	647,021	1,874,005

[a]Coal exports excluded.

Source: Ref. 6.

space for 79,928 cars. They were followed by the Gulf coast ports, with room for 33,404 freight cars; the South Atlantic ports, which could accommodate as many as 14,150 cars; and, finally, the Pacific coast ports, which could store at most only 14,123 cars.[9] Over one-fourth of the aggregate freight-car-storage capacity was concentrated at New York Harbor, which had space for a maximum of 36,847 cars. The other principal ports and their freight-car-storage capacities during World War II were as follows:

- New Orleans -- 13,528 freight cars;
- Hampton Roads, Virginia -- 13,221;
- Baltimore, Maryland -- 9,805;
- Philadelphia -- 8,625;
- Boston -- 5,389;
- Los Angeles -- 2,875;
- Portsmouth, New Hampshire -- 1,846;
- San Francisco -- 1,731; and
- Portland, Oregon -- 1,380.[9]

Control Measures

Control over the movement of freight to the nation's seaports began long before the United States entered the war. Responding to vivid memories of the fiasco during World War I, the AAR and the Army together developed a plan for controlling export traffic. This plan was implemented on November 13, 1939, because of the increase in traffic moving to the North Atlantic ports as a result of the outbreak of war in Europe.

The plan was administered by the AAR's Car Service Division, which appointed a Manager of Port Traffic to regulate the flow of traffic to and through the North Atlantic ports. The Port Manager's authority was subsequently extended over ports of the Gulf coast and west coast as well. The railroads submitted daily reports to the Port Manager, with data on the number of cars unloaded, the number of cars in the port areas, the number of cars delayed and not released promptly, the amount of export freight in storage, and the availability of lighters, barges, and carfloats.[6]

Port committees were organized at each of the principal ports. They included representatives from the Army, Navy, steamship companies, Lend-Lease agencies, the ODT (after the United States entered the war), and the railroads. The chairman of each committee was usually the Commanding Officer of the Army Port Agency. It was the task of committee members to keep themselves informed on conditions at the port under their jurisdiction and to take corrective actions before any problems became too serious. In effect the port committees served to decentralize the coordination and supervision of export activities.[6]

The AAR's Car Service Division also implemented a permit system. In applying for a permit from the Manager of Port Traffic, shippers had to certify that steamship space was available. Freight agents could not accept a shipment consigned to a port until the shipper presented a release or permit issued by the Port Manager.[6]

The Army established its own method of control in August 1941 to manage the movement of all Army and War Department Lend-Lease freight destined to a port. Under the Army's scheme, shippers had to apply for release and routing orders from the Commercial Traffic Branch of the Office of the Quartermaster General. Orders were issued only after it had been ascertained that ocean transportation was available. This system worked well before the United States entered the war but was found to be ineffective afterward.[6]

Thus, before the United States became militarily involved in the war, steps were taken to prevent the kind of congestion that nearly strangled the ports during World War I. Nevertheless, severe congestion did develop in early 1942 at some of the upper Atlantic ports, particularly at Philadelphia. The problem, which arose because of a lack of control over Lend-Lease supplies to the Soviet Union, became the impetus for the creation of a centralized control system over all port-bound traffic.

The system of centralized control over port traffic during the war evolved gradually. It began with Executive Order No. 8989, which created the ODT and gave that agency the responsibility for coordinating all domestic traffic movements with ocean shipping.

One of the early actions taken by the ODT dealt with the problem of "frustrated" freight, export freight that had been consigned before the outbreak of war in Europe and could not be shipped overseas either because shipping was unavailable or because service to the foreign destinations involved was restricted. There were, for example, 2,866 carloads of "frustrated" freight at the Port of New York on June 1, 1942.[6] On June 27, the ODT issued General Order No. 12, requiring the railroads to remove any "frustrated" freight they had in the ports they served. This freight was either disposed of by the owners or moved to inland storage. Thereafter, before any freight could be consigned to a port area for storage, a port-storage forwarding permit had to be obtained from the Director of the Division of Storage within the ODT.

A Transportation Control Committee was established to coordinate the activities of agencies involved in the movement of export traffic. On the Committee were representatives from the Army, the Navy, the War Shipping Administration (WSA), the ODT, and the British Ministry of War Transport. The Committee met daily to review information on port conditions and ocean transportation. It issued permits to the various government procurement agencies and other shippers according to the amount of shipping space allocated to each by the WSA. Under ODT General Order No. 16, one of three conditions had to be met before a permit could be issued to any procurement agency or commercial shipper:

- Cargo space had to be available in the vessel named on the permit, or

- Cargo space would have to become available within a reasonable amount of time after the shipment arrived at the port, or

- A "bank" of storage space had to be maintained at the port to hold the shipment temporarily.[6]

As sudden changes occurred in ocean-transportation schedules, the Transportation Control Committee delayed or expedited the affected shipments, as appropriate.

In the spring of 1943, the WSA created a Port Utilization Committee (PUC) with representatives of the same agencies as were on the Transportation Control Committee. The PUC assigned shipping tonnages and export loads to each port, proposed shipping schedules for a month in advance, and generally ensured that port facilities were not overburdened. This committee also controlled import cargoes to prevent their interfering with export movements.

Because of centralized control, no serious congestion occurred at any of the ports during World War II. Threats of local congestion occasionally arose, but corrective measures were always immediately taken.

4.4.4 Domestic-Waterways Transportation

The domestic-waterways system includes the inland navigable rivers and canals, the Great Lakes, intracoastal waterways, and coastal and intercoastal routes. During World War II, the volume and share of intercity freight traffic on the system as a whole declined. Table 4.12 shows that annual ton-miles of freight on the domestic-waterways system dropped 49.2% between 1941 and 1943 before recovering somewhat in 1944 and 1945. Even before the war, the proportion of intercity freight traffic shipped via the domestic-waterways system had been declining. The war accelerated this trend as the percentage of intercity ton-miles transported on the waterways fell from 41.0% to 17.5% in just three years' time. These statistics, however, can be misleading; they primarily reflect the acute reduction in coastal and intercoastal shipping caused by German submarines. Some components of the domestic-waterways system, such as the Great Lakes, had an increase in traffic during the war and played a key role in the movement of certain commodities. For this reason, the wartime circumstances of each type of waterway are described separately in this section.

Great Lakes

Shipping on the Great Lakes was used extensively during the war to transport iron ore, coal, grain, limestone, and petroleum. Tables 4.13 and 4.14 show the volumes of freight shipped across the Lakes just before and during the war years. Overall traffic on the Lakes rose rather sharply between the time hostilities started in Europe and the time the United States entered the conflict. Thereafter, traffic tended to fluctuate from year to year for each commodity. Yearly differences in the length of the navigation system accounted for much of this annual variation in the volume of freight traffic on the Lakes.

TABLE 4.12 Volume of Freight Traffic on the Domestic-Waterways System during World War II[a]

Year	Ton-Miles (10^6)	Share of Total Intercity Freight (%)
1939	330,951	41.34
1940	361,465	40.95
1941	386,045	37.17
1942	234,847	22.41
1943	196,175	17.50
1944	206,857	17.49
1945	259,940	22.10

[a]Includes inland waterways, Great Lakes, intracoastal waterways, and coastal and intercoastal routes.

Source: Ref. 10.

TABLE 4.13 Total Volumes of Freight Traffic on the Great Lakes during World War II

Year	Ton-Miles (10^6)	Net Tons
1939	76,312	114,229,856
1940	95,645	145,216,410
1941	113,639	172,286,616
1942	122,167	182,731,421
1943	115,346	175,652,684
1944	118,769	184,159,492
1945	113,028	175,082,683

Sources: Refs. 11 and 12.

TABLE 4.14 Volumes of Freight Traffic on the Great Lakes during World War II, by Type of Commodity

Year	Gross Tons of Iron Ore	Net Tons of Coal	Net Tons of Grain	Net Tons of Limestone	Net Tons of Gasoline and Oil
1939	45,072,724	N.R.[a]	11,172,079	12,208,205	N.R.
1940	63,712,982	49,319,604	9,644,950	14,893,985	N.R.
1941	80,116,360	53,535,365	11,387,480	17,633,448	9,387,060
1942	92,076,781	52,533,792	8,501,586	18,570,048	14,172,053
1943	84,404,852	51,969,459	11,810,116	17,339,675	9,449,867
1944	81,170,538	60,163,330	16,228,880	16,856,279	10,195,912
1945	75,714,750	55,246,197	18,717,773	16,318,193	9,363,709

[a]N.R. = not reported by source.

Source: Ref. 12.

Ore transportation on the Lakes was particularly important. During the war, almost 90% of the iron ore used by the steel industry in the United States and Canada was mined in the Lake Superior region. All but 1% of this ore was transported in bulk cargo vessels on the Lakes. Vessels were even diverted from grain and coal transportation to handle the ore traffic. In fact, only vessels unsuited for transporting ore were allowed to carry grain.[6]

Coal transportation via the Great Lakes was closely regulated by the ODT and the SFAW. Coal shipped across the Lakes to Lake Erie, Detroit River, and Chicago district ports could not move without a permit from the ODT. Only vessels specially designed for transporting coal were allowed to carry that commodity. In August 1943, the SFAW issued a regulation prohibiting the shipment of coal to Washington state, Oregon, Idaho, Montana, or Wyoming via the Great Lakes. In January 1945, the SFAW issued another regulation permitting coal shipments on the Great Lakes only when the shipper had either a written contract executed on or before February 20, 1945, or written permission from the SFAW. This agency also specified the amount of coal that could be received at each lake dock. To make the most of the short and uncertain navigation season, the SFAW instructed shippers to arrange their distribution schedules for the period from April 1 to November 17, 1945, so that all coal orders could be fully met and to apportion their coal shipments in equal monthly installments throughout the navigation season.[6]

Despite the diversion of lake vessels from coal transportation, coal traffic on the Lakes reached record volumes due to an increase in coal shipments to Canada, industrial expansion in the Detroit area, and an increase in coal shipments to Duluth and Superior.

Grain transportation via the Great Lakes also reached record levels before the end of the war. New records in net tons shipped were attained in 1944 and 1945 because of the unprecedented demand for feed grains in the United States and because of record wheat crops and exports to Europe. Considerable quantities of grain from the northern plains were loaded into lake vessels at Duluth, Minnesota, and at Fort William and Port Arthur in Canada and transported to unloading docks at Erie, Pennsylvania; Cleveland; Toledo, Ohio; Oswego, New York; and Chicago. Canadian vessels usually carried most of the grain that moved over the Lakes. In 1944, however, U.S. vessels hauled 292,326,961 bushels, 765,119 more than the Canadian vessels. In 1945, U.S. ships carried 371,683,645 bushels of grain, 60 million bushels more than were transported in Canadian ships.[6]

Shippers had to obtain special permits from the ODT before they could ship grain over the Lakes. As was mentioned previously, the grain could only be shipped in vessels not suited for ore transportation.

Limestone mined in Michigan was loaded into lake vessels at ports on Lakes Michigan and Huron and transported to ore-receiving ports on Lake Michigan, Lake Erie, and the Detroit River.

Gasoline and oil were shipped from Chicago to Toledo, Ohio, and Buffalo, New York, via the Great Lakes in tankers and barges. The prewar U.S. fleet consisted of 20 tankers and two barges in regular service and 30 migrating vessels, mostly barges. In addition, there were 35 Canadian vessels. The U.S. fleet eventually grew to 33 tankers.[6]

The Great Lakes fleet shrank in numbers between the beginning and end of the war. In December 1941, the fleet included 734 U.S. and Canadian vessels, with an aggregate tonnage of 3,181,240 gross tons. Some vessels were diverted from Great Lakes service to ocean transport. For example, the WSA in 1942 requisitioned 47 vessels, with an aggregate tonnage of 128,218 gross tons, for ocean and coastal duty. The size of the Canadian grain and coal fleet was reduced from 136 to 73 steamers, resulting in a loss of 114,019 gross tons. By the close of the navigation season in 1945, the Great Lakes fleet was down by 64 vessels and 208,051 gross tons compared with its size at the start of the war.[6]

Inland Waterways

As Table 4.15 shows, freight traffic on the nation's inland rivers and canals remained fairly constant during the war (after rising 34.5% between 1939 and 1941). The capacity of the inland waterway system was never fully used during the war, because the movement of river vessels was generally too slow to meet the pressing wartime demands. Large quantities of bulk commodities well suited to transportation by water were shipped by rail instead.

The effect of the war on freight traffic volumes varied among the different subsystems of the inland waterways system. As Table 4.15 shows, traffic volumes on the Mississippi River and its tributaries, the most extensive and heavily used subsystem, fluctuated from year to year. Traffic volumes on Pacific coast rivers showed no significant increase, while volumes on Atlantic and Gulf coast rivers generally declined.[6]

TABLE 4.15 Volumes of Freight Traffic on Inland Rivers and Canals during World War II

Year	Ton-Miles on All Rivers and Canals (10^6)	Mississippi River System	
		Ton-Miles (10^6)	Short Tons
1939	19,937	12,369	76,068,399
1940	21,651	13,934	88,980,317
1941	26,815	17,037	99,595,957
1942	26,398	16,499	100,351,044
1943	26,306	16,765	93,561,533
19[illegible]4	31,386	20,382	101,340,788
1945	29,709	19,595	95,543,335

Source: Ref. 11.

Although the war did not induce any significant increase in river freight traffic, it did alter the normal pattern of waterway transport. In general, volumes of coal, iron ore, sulfur, petroleum, and petroleum products increased at the expense of merchandise traffic, which declined sharply. Upstream traffic on the Mississippi River system increased considerably, while downstream shipments dropped off. New traffic flows developed. For example, war craft produced in Pittsburgh, Leetsdale, Ambridge, and Midland, Pennsylvania; Point Pleasant, West Virginia; Ironton, Ohio; and Jeffersonville and Evansville, Indiana, reached the sea via the Ohio and Mississippi Rivers. Barges carrying 40,000 bbl/d of oil, gasoline, and heating oil moved from a new terminal on the Mississippi River at Helena, Arkansas, to points along the Ohio River.[6]

The inland-waterways fleet was generally too small to offset the loss of shipping on coastal and intercoastal routes. At the beginning of 1939, only 7,910 commercial vessels plied the nation's inland rivers and canals. Approximately three-fourths of these vessels were over ten years old, and nearly half were over 15 years old. The ODT did augment the fleet somewhat by sponsoring the building of 629 new river vessels. All of these additional vessels were in operation by the end of the war.[6]

Intracoastal Waterways

The Gulf and Atlantic intracoastal waterways were the only major segments of the domestic-waterways system to grow significantly in freight traffic during the war. Because these channels afforded protection from enemy submarines, they received a considerable portion of the traffic that formerly had moved on the coastal ocean routes before the German blockade. Ton-miles of freight traffic on the intracoastal waterways rose from 2.84 billion in 1939 to 3.74 billion in 1940, 4.95 billion in 1941, 6.02 billion in 1942, 6.08 billion in 1943, 7.88 billion in 1944, and 6.52 billion in 1945.[6]

The Gulf Intracoastal Canal was an especially important artery for petroleum traffic. Barges transported gasoline at a rate of approximately 24,000 bbl/d between Corpus Christi, Texas, and Carrabelle, Florida. From Carrabelle, the gasoline was pumped through pipelines to Jacksonville, Florida, where it was loaded into oil barges and delivered to points along the Atlantic Intracoastal Canal as far north as Wilmington, North Carolina. Barges also transported residual oil from various points along the Texas coast to Panama City, Florida, where the fuel was transferred to tank cars. Oil was transported via the Gulf Intracoastal Canal to Port St. Joe, Florida, where it was then transshipped by pipeline to terminals in Georgia and Tennessee. Short hauls between terminals in Texas and Louisiana also accounted for a sizable amount of petroleum traffic along the Gulf intracoastal waterway.[6]

Coastal and Intercoastal Routes

Coastal and intercoastal shipping was the only part of the domestic transportation system to be damaged directly by enemy action during World War II. Because of German submarine attacks, traffic on the coastal and intercoastal routes plummeted from 155,857,000 short tons in 1941 to 73,977,000 in 1942 and 59,789,000 in 1943. Many of the approximately 400 dry-cargo vessels and 300 tankers that operated on the coastal and intercoastal waterways were placed in convoys and used for transoceanic transport. Coastal and intercoastal traffic recovered somewhat after 1943 as the German submarine threat abated. In 1944, 70,784,000 short tons were shipped, while in 1945, traffic increased to 90,691,000 short tons (still well below prewar levels).[6] The widespread consequences arising from the destruction of coastal and intercoastal shipping have already been mentioned.

4.4.5 Motor Transportation

At the start of World War II, intercity trucking was still a young but expanding industry. Its share of total intercity ton-miles of freight (excluding domestic coastal shipping) had risen from 4.0% in 1926 to 10.5% in 1941.[6,13] It is difficult to determine how many motor carriers of property existed at the start of the war, but by August 31, 1944, there were 2,983,466 private carriers owning 4,136,928 trucks and 360,928 for-hire carriers owning 632,508 vehicles.[6] Thus, the industry consisted of a large number of small firms.

Special Problems of the Trucking Industry

Although intercity motor carriers made important contributions to the war effort, they were severely hampered by the U.S. government's suspension of truck manufacturing during the war and by shortages of vital materials.

On January 1, 1942, the WPB issued an order stopping the sale of all new trucks for civilian use. The existing supply of 185,000 new trucks was pooled, and 97,000 were allocated for civilian use.[6] Priorities were established for releasing trucks from the pool, based on five classes of use. The highest priority was given to military, public

health and safety, and communications uses. These uses were followed, in descending order of priority, by uses directly connected with the war effort, essential functions indirectly connected with the war effort, transportation of people and goods not connected with the war effort, and nonessential or luxury uses.[6]

In March 1942, the U.S. government suspended all manufacturing of trucks for civilian use. This ban, however, was gradually lifted in the following years. The government authorized limited production of heavy trucks in May 1943, medium-weight trucks in January 1944, and light trucks in January 1945. Only 2,888 new trucks were built in 1943. In the following year, however, the number increased sharply, to 119,081.[6]

The motor carriers, therefore, were forced to retain their older vehicles for a longer than normal period of time. The average age of the truck fleet rose from 5.6 years on July 1, 1941, to 8.7 years on July 1, 1946. In July 1941, less than half of the trucks in use were over five years old. By August 1944, 70% of the trucks in operation were over five years of age, and by July 1946, the percentage had risen to nearly 85 percent. In 1941, less than 20% of all trucks in operation were ten or more years of age. By 1946, 35% were at least ten years old.[6]

Intercity trucking was greatly constrained by critical shortages of tires, replacement parts, motor fuel, and manpower. The Japanese blocked American access to Far East sources of crude rubber. Although the synthetic rubber program was able to meet military and high priority civilian requirements, it could not provide enough rubber to meet all needs. Replacement parts became scarce not just because of shortages of materials needed to make them. Occasionally, the military would appropriate materials intended for civilian use. Parts manufacturers often diverted materials intended for parts production to more profitable uses. Fuel shortages, particularly in the East, arose because of the disruption of coastal shipping, the diversion of oil tankers from domestic petroleum transport, and the huge military and industrial demand for petroleum products. Military inductions created an acute shortage of manpower in the motor carrier industry. Although line-haul trucking was considered essential, it nevertheless was considered secondary to the war production program.[6]

Wartime Control

To exercise some form of control over the diverse motor-carrier industry and to mobilize it for the war effort, the ODT on September 8, 1942, issued an order requiring every owner of a commercial vehicle to obtain a Certificate of War Necessity. These certificates were the ODT's principal means of enforcing its orders to eliminate wasteful and unnecessary practices and services and to conserve gasoline, tires, and equipment. A separate certificate was issued for each vehicle. The certificate specified the maximum number of miles the vehicle could be driven, the minimum load it could carry, and the amount of gasoline allocated to it. Commercial vehicle operators had to present their certificates to obtain coupons enabling them to purchase fuel, tires, and tubes.[6]

During the war, the ODT issued numerous conservation orders designed to eliminate circuitous routing, end wasteful practices, increase loading, and, in general, conserve fuel, tires, and equipment.

To eliminate circuitous routing, the ODT prohibited common carriers from following any route whose length exceeded that of the most direct route by 10 percent or more. Private and contract carriers had to reduce their mileage each month by 25% compared to their mileage during the same month in 1941.[6]

Trucks had to be fully loaded over a considerable portion of a trip, including the return trip. At first, the ODT permitted two or more carriers to establish Joint Information Offices to help carriers find freight or excess equipment. If they could not find sufficient freight to make up a full load, common carriers (as well as private and contract carriers) had to lease their trucks to other carriers through the Joint Information Offices. This scheme, administered by the trucking industry, was not very successful. The ODT finally took over the program in March 1944 and administered it through its 142 district offices. Common carriers were required to register any empty or partially loaded vehicles as well as any cargo they could not handle. Contract and private carriers simply had to register any empty vehicles. The ODT district offices then matched the available equipment with the available freight. The program saved an estimated 100 million miles of empty or partially loaded hauls each year.[6]

The ODT encouraged the motor carriers to adopt joint-action plans to eliminate excessive and wasteful operations. The following cooperative actions were permitted with ODT and ICC approval: coordination of schedules, suspension of less-than-truckload (LTL) services, reciprocal exchange of shipments of property, pooling of traffic or revenue, joint loading or operation of trucks, traffic diversion, joint operation of terminals, joint operation of pick-up and delivery vehicles, and equipment interchange.[6] Carriers undertaking such joint actions were protected from antitrust suits by the Small Business Concerns Act. Joint-action plans were especially successful in the coal industry. Private carriers of solid fuels saved an estimated 143,464,000 miles annually, while for-hire carriers of solid fuels saved an estimated 85,049,000 miles annually.[6]

The ODT prohibited tank trucks from hauling petroleum more than 200 miles. However, the tank trucks replaced railroad tank cars for short hauls, thus freeing 25,000 of the latter for the long-distance movement of oil to the East. There were about 106,000 tank trucks and 15,000 tank trailers and semitrailers, most of them owned by private carriers. Approximately 75% of this equipment was used to distribute petroleum products locally.[6]

Truck traffic was frequently diverted to the railroads. In areas where trucks were scarce, two or more motor carriers were allowed to consolidate shipments into carload lots for transportation by rail. Such transferring of truck traffic to the railroads was subject to ODT approval.[6]

Farm Trucks

Approximately 1.6 million trucks -- about 35% of all trucks registered -- were used to transport agricultural products from farms.[6] These trucks were owned and operated by farmers, contract carriers, food processors, and marketing and processing cooperatives. Because of the magnitude of wartime food production, the large number of vehicles involved, the variety of transport services involved, and the complexity of the

marketing system, controlling the movement of agricultural products from the farms was especially difficult.

Like all other owners of commercial vehicles, farmers and farm-truck operators had to apply for Certificates of War Necessity. Because farm-truck operators were not covered by ICC regulations, they generally were not used to being regulated. Many of them were unfamiliar with regulatory procedures and, in particular, were unaware of the Certificate of War Necessity program and its requirements. The ODT, therefore, had to enlist the aid of the U.S. Department of Agriculture to publicize the program and educate farmers and farm-truck operators about applying for certificates.[6]

The initial mileage and gasoline allowances specified on the Certificates of War Necessity for farm trucks were generally insufficient. Farmers and farm-truck operators were encouraged to appeal these allowances and were assisted in doing so by County Farm Transportation Committees established in all of the counties in the country by the Department of Agriculture. The ODT was generally willing to increase the original mileage and gasoline allowances because of the importance of food production and transportation to the war effort. However, in granting these appeals for higher allowances, the ODT insisted that certain wasteful and excessive farm-truck operations be eliminated. These operations included the following:

- Transporting farm products to, or farm supplies from, a point beyond the nearest available market;
- Operating empty farm trucks when full or partial loads were available;
- Operating partially loaded farm trucks where regular collection routes had been established and were available;
- Operating in a scheduled service over roads likely to cause undue wear of tires or vehicles;
- Using large, heavy farm trucks when lighter, smaller ones were suitable and available; and
- Using farm trucks solely for transporting passengers (except where no other means was available).[6]

The ODT and the County Farm Transportation Committees also encouraged the community pooling of farm trucks.

Various industry transportation advisory committees were established at the regional and local levels to devise plans for making better use of available farm transportation equipment. These committees were composed of representatives of producers, carriers, processors, and dealers of particular commodities in designated areas. Committees were formed to deal with producers of dairy products, livestock, perishable and seasonal farm products, and poultry.[6]

Motor-Carrier Operations

The shortages of fuel, tires, replacement parts, and manpower, the rationing of fuel and tires, and the various federal restrictions placed on the motor carriers effectively halted the trucking industry's prewar growth in intercity freight operations. In fact, as Table 4.16 indicates, these factors actually reversed the prewar trend. Motor carriers hauled 21 billion fewer ton-miles of intercity freight in 1942 than in 1941, a reduction in freight traffic of almost 26%. In the following year, motor-carrier intercity freight traffic fell an additional three billion ton-miles. The trucking industry's share of total intercity freight, excluding domestic coastal transport, decreased from 10.5% in 1941 to 5.3% in 1944 at the same time that the total number of ton-miles of intercity freight increased by 40%.[13]

Table 4.16 also shows that wartime circumstances affected regulated and nonregulated motor carriers differently. The ICC regulated carriers actually transported increasing quantities of intercity freight during each succeeding year of the war, while the nonregulated carriers lost 116 million tons of freight during the first two years of the war. Thus, whereas the regulated carriers hauled only 20% of all the tons of intercity freight transported by motor carriers in 1941, they hauled 33% in 1943 and 1944.

The various conservation orders issued by the ODT and enforced by the rationing and Certificate of War Necessity programs reduced vehicle miles of travel (VMT) by motor carriers of property and increased average loads. Total VMT on all rural roads by motor carriers of property had risen from 22 billion miles in 1936 to 34 billion miles in 1941. During the war years, the annual VMT was 27 billion miles in 1942, 25 billion miles in 1943 and 1944, and 27 billion miles in 1945.[6] Again, the effects of wartime control differed between regulated and nonregulated carriers. For-hire motor carriers operated

TABLE 4.16 Motor-Carrier Intercity Freight Traffic During World War II

Year	Ton-Miles (10^9)	Share of Total Intercity Ton-Miles[a] (%)	Freight Hauled (10^6 tons)	
			ICC-Regulated Carriers	Non-ICC-Regulated Carriers
1939	53	9.7	48	193
1940	62	10.0	61	211
1941	81	10.5	77	312
1942	60	6.5	83	204
1943	57	5.5	96	196
1944	58	5.3	105	218
1945	67	6.5	108	286

[a]Domestic coastal transport is excluded from the total.

Source: Ref. 13.

about 60% more vehicle miles in 1944 than in 1936, whereas the private motor carriers operated almost 2% fewer vehicle miles between the same two years.[6] The average load carried by trucks on main rural roads had increased from 3 tons in 1936 to 3.6 tons in 1941. During the war years, the average load per truck was 4.1 tons in 1942, 4.4 tons in 1943, 4.6 tons in 1944, and 4.8 tons in 1945.[6] In this case, the percent increase in the average load was virtually the same for both for-hire and private motor carriers of property.

4.4.6 Pipeline Transportation

Prewar Pipeline Network

In 1939, the domestic pipeline network consisted of 61,500 miles of crude oil trunk lines, 53,700 miles of crude oil gathering lines, and about 6,000 miles of refined oil trunk lines. Approximately half of the crude oil pipeline mileage was located in Texas and Oklahoma.[6]

The trend in the pipeline industry was toward wider pipe diameters and, hence, increased capacity. The average diameter of a crude oil trunk line in 1941 was 8.4 in., 0.4 in. wider than the average in 1931. The average diameter of a petroleum-product trunk line in 1941 was 7.34 in., compared with 7 in. in 1931. In 1941, the crude oil trunk lines had a capacity of 23,448,000 bbl, up 16% over 1936.[6]

Wartime Pipeline Construction and Conversion

The disruption of coastal shipping, the principal means of getting oil to the eastern seaboard, triggered a rapid expansion and conversion of the pipeline network. During the war, 9,845 additional miles of pipeline were installed at a cost of $288 million. In addition, 436 miles of natural gas pipeline were converted to transportation of oil, and the direction of the oil flow was reversed in 3,317 miles of existing pipeline.[6]

One of the most important projects was the War Emergency Crude Oil Pipeline, also known as the "Big Inch." Twenty-four inches in diameter, this pipeline stretched 1,254 miles from the East Texas oil fields near Longview to the oil refineries near New York and Philadelphia. The U.S. government funded its construction, which began August 3, 1942, and ended July 19, 1943. When completed, the Big Inch conducted 300,000 bbl/d of crude oil to the east coast. It replaced 30,000 tank cars, which were diverted to shorter hauls.[6]

Another important new pipeline was the War Emergency Products Line (the "Little Big Inch"). Twenty inches in diameter, this pipeline went from Beaumont, Texas, to the New York City area, a distance of 1,475 miles. Also a government enterprise, it was constructed between April 23, 1943, and March 2, 1944. It had a capacity of 235,000 bbl/d of gasoline.[6]

Wartime Traffic

In the years just before the U.S. joined the war, oil pipelines transported 148 million tons of petroleum and petroleum products in 1939, 154 million tons in 1940, and 171 million tons in 1941.[13] During the nation's first year in the war, the amount of petroleum pumped through the nation's pipelines increased by only four million tons over 1941, well below the annual increases of previous years. However, as more miles of petroleum pipeline were added to the network, the volume rose considerably. Oil pipelines conducted 196 million tons of petroleum in 1943, an increase of 21 million tons over the previous year, and 244 million tons in 1944, an increase of 48 million tons over 1943, before declining to 241 million tons during the last year of the war.[13]

More notable was the tremendous increase in the amount of oil transported to the East by pipeline. As Table 4.10 shows, pipelines delivered only about 3.5% of the East's daily oil supply in 1941. During the war, though, pipelines accounted for 9.9% of the daily supply of oil to the east coast in 1942, 19.2% in 1943 (surpassing the oil tankers), 38.7% in 1944 (surpassing the railroads), and 40.4% in 1945. The daily volume of oil delivered by pipeline to the East more than doubled in 1942 over 1941, more than doubled again in 1943 over 1942, and increased almost two and one-half times in 1944 over 1943. During the last year of the war, pipelines transported more than 13.5 times as much petroleum a day to the east coast as they had in 1941. Together with the railroad tank cars, the expanded pipeline network was able to offset much of the early loss in coastal shipping that had delivered virtually all of the eastern seaboard's oil before the war.

4.5 OCEAN TRANSPORTATION

As in World War I, ocean transportation was a critical (if not the most important) factor affecting the logistics of the war. Regardless how many troops were mobilized, how much food, clothing, and weaponry the economy could produce, how much freight the railroads could deliver to the ports of embarkation, or how much freight the ports could hold, it was the availability of ocean shipping that determined how many troops and how much of their equipment could be sent into the theaters of war. This availability, more than any other factor, governed the movement of rail freight to the ports. Military campaigns were frequently delayed because of a shortage of merchant ships. The Allies* never seemed to have enough ocean shipping available for the task at hand.[2]

Many other problems accompanied the central problem of finding enough ships. Some of these problems caused delays in ocean transportation that contributed to the shortage of vessels. Poor facilities and limited capacity at some ports, especially those overseas, increased embarkation and debarkation times. In the absence of shore facilities near battle zones, ships were often used for storage despite long-standing policies against such use. Convoys were needed to make the Atlantic crossing, and much time was spent waiting for them to be formed. The greatest contributors to the shortage

*The principal Allies in World War II were France, Great Britain, the Soviet Union, and the United States.

of ships and problems of ocean shipping were the enemy's airplanes, surface raiders, and submarines.

4.5.1 Condition of U.S. Merchant Marine

In 1939, the United States had the second largest merchant marine in the world. As of June 30 of that year, the U.S. oceangoing fleet consisted of 851 freighters, 384 tankers, and 163 vessels that carried both passengers and freight. All of these ships had a gross tonnage of at least 1000 tons. The 1,014 dry-cargo vessels had an aggregate gross tonnage of 5,430,649 tons and an aggregate dead-weight tonnage of 7,443,260 tons. The 384 tankers had an aggregate gross tonnage of 2,704,241 tons and an aggregate dead-weight tonnage of 4,255,580 tons. Of the 1,398 ships in the fleet, 1,092 (78.1%) were active.[14]

The essential problem was the generally poor quality of the fleet. Most of the ships had been built in the years immediately after World War I; consequently, 90% of the fleet was obsolete. The ships were predominantly of one size; three-fourths of them were in the 5,000 to 10,000 gross tons range. Only eight vessels had a gross tonnage exceeding 20,000. About three-fourths of the fleet operated at speeds under 12 knots.[14] Thus, in terms of the number of U.S. flag vessels available to the government, the United States was in a better position in 1942 than it was in 1917. In terms of the quality of the fleet, however, the United States' position was not especially favorable.

4.5.2 Shipping Losses

Total Allied and neutral shipping lost in World War II was nearly double that of World War I. Between September 1939 and August 1945, Allied and neutral nations lost 24 million gross tons of ocean-transport capability.[1] The United States lost 674 oceangoing ships of 1000 gross tons or more, nearly half the capacity of the 1939 fleet.[2]

The heaviest losses occurred during the first half of the war. By the summer of 1942, Allied and neutral shipping losses exceeded new-ship construction by ten million gross tons. Total losses peaked in November 1942, at over 900,000 gross tons for the month. Thereafter, a decline in losses, together with construction of new ships, gradually narrowed the deficit until, by October 1943, the cumulative loss of shipping was eliminated.[1]

4.5.3 U.S. Ship Production

Table 4.17 shows the results of the United States' shipbuilding efforts shortly before and during the country's involvement in World War II. In this war, the U.S. had a better head start than it had in World War I. Responding to the increasingly threatening situations in Europe and the Far East, the United States in 1941 nearly doubled the relatively small output of the shipbuilding industry during the previous year. In 1942, the country produced over seven times as many ships as in 1941, and in 1943, ship production was nearly 19 times higher than it had been just before the war. Between 1941 and 1945

TABLE 4.17 U.S. Ship Production Shortly before and during World War II

Year	Number of Vessels[a]	Aggregate Gross Tons	Aggregate Dead-Weight Tons
1938	25	181,907	289,765
1939	28	241,609	341,219
1940	54	449,221	638,037
1941	103	804,114	1,159,765
1942	760	5,411,098	8,044,527
1943	1,949	13,024,143	19,209,991
1944	1,786	12,257,435	16,299,985
1945	1,097	7,731,903	10,598,154

[a]Steel vessels of 1000 gross tons or more.

Source: Ref. 14.

inclusive, the United States built 5,695 steel vessels of 1000 gross tons or more, four times the number of ships in the U.S. merchant marine in 1939.

Improved assembly-line methods, including broader use of prefabricated parts, were largely responsible for this tremendous expansion in American shipbuilding. It took 244 days to build the first Liberty ship. By December 1943, ships were being produced at an average rate of one every 39.2 days.[1]

4.5.4 Wartime Control

As in World War I, all Allied shipping was pooled. Two pools were created. One pool, containing British as well as American ships, was placed under the centralized control of the War Shipping Administration, established by President Franklin Roosevelt in February 1942. The WSA allocated available shipping space from this pool among the many entities claiming a need for ocean transportation, including Lend-Lease agencies, private enterprises, Allied governments, the Army, and the Navy. Vessels allotted to the military were further allocated by the Combined Chiefs of Staff through the Combined Military Transportation Committee and by the Joint Chiefs of Staff through the Joint Military Transportation Committee. The second Allied pool of shipping operated from London under British control.

The Army retained control over its own ships, but it nevertheless had to keep the WSA informed about the movement of these vessels. The WSA would often assign return cargoes to them. In actuality, the Army did not operate many of its vessels. For example, in July 1945, it operated only 186 of the 1,706 vessels in its service.[1] At first,

the Navy provided crews to man and operate the Army's transports, as it had done during World War I. The Army made several attempts to form a unified Army and Navy ocean transportation service, but these attempts never succeeded. Ultimately, the WSA operated most of the ships, using civilian crews.

4.6 SUMMARY

World War II confronted the United States with some of the most difficult domestic-transportation problems the country had ever faced. The war generated the highest volumes of freight traffic ever handled up to that time. It disrupted and distorted normal patterns of freight flow and created new patterns, often in remote or less developed parts of the country where transportation facilities were generally inadequate. It spawned shortages of manpower and vital materials needed to maintain, operate, and expand the transportation system. Yet the U.S. freight-transportation system met these unprecedented challenges more efficiently and effectively than it had met the somewhat less complex challenges of World War I.

Certainly, the country's unhappy experience with domestic transportation in the previous war had much to do with the extraordinary performance of the transportation system during World War II. The government, the military, and the carriers generally knew what to do to avoid the congestion that paralyzed many of the ports and much of the railroad system in 1917. Many of the control measures instituted in 1918 were implemented again just before or immediately after the United States' entrance into World War II. Still, neither the government, the military, nor the carriers were prepared in 1942 for anything of the size and scope that World War II became.

As it had been in 1918, the key to efficient and effective operation of domestic transportation in World War II was centralized control. There were 121 Class I railroads, nearly three million nonregulated motor carriers of property, over 360,000 ICC-regulated intercity trucking firms, and numerous other private, independent carriers, transshippers, port and storage-facility operators, freight forwarders, and shippers whose activities had to be coordinated to keep the freight flowing without interruption. The task of unifying and coordinating the diverse parts of the transportation system was assigned to the Office of Defense Transportation, created shortly after the United States entered the war.

An essential lesson of the war was that the U.S. government did not have to take possession of the various modes of transportation to achieve intermodal and intramodal coordination. The government did impose numerous restrictions on the operations of the various carriers, and these restrictions were often necessary to conserve available equipment, fuel, and vital materials that were in short supply. Some restrictions on operations were also necessary to eliminate wasteful or inefficient practices and thereby expedite the movement of freight. Government orders to private operators, however, did not constitute the only element of centralized control. Another important element consisted of cooperative agreements. Much was accomplished through persuasion and cooperation. The ODT and the ICC continually urged and pressured the carriers to abandon wasteful practices and adopt more expeditious procedures. These agencies sought and relied heavily on the advice of traffic experts in formulating orders and other

control measures. Private organizations, such as the AAR, often assisted the ODT and ICC in ensuring that control measures were being executed properly. Numerous local and regional committees, composed of representatives of shippers, carriers, and the regulatory agencies, were founded to deal with specific problems, such as the transportation and storage of grain, the distribution of refrigerator cars, and the movement of farm products by truck. Generally, the U.S. government relied on cooperative efforts first. Only when these efforts failed or when strict controls were imperative did it take stronger measures, issuing orders or imposing restrictions on shippers and carriers.

Cooperation and coordination was as much a problem among government agencies as it was among modes of transportation. Although the ODT was the primary agency responsible for all transportation within the country, it had to share some of its functions and powers with other agencies, particularly the ICC. More important, it had to coordinate its activities with those of numerous other government agencies that arose during the war to control aspects of war production. These agencies often took actions or adopted measures that directly affected transportation operations. A few of the agencies, such as the War Food Administration and the War Production Board, even had power to direct the movement of certain commodities. Not surprisingly, numerous jurisdictional disputes and other conflicts arose between the ODT, the ICC, and the various government agencies concerned with war production.

The railroads bore the brunt of the burden during the war. Not only did they account for over two-thirds of the total intercity ton-miles of freight hauled each year, but also their share of intercity freight traffic steadily increased until the final year of the war. When German submarines severely disrupted coastal shipments of coal and oil, the railroads had to take on much of the load previously carried by ocean vessels.

By contrast, traffic on the Great Lakes and the inland waterways did not increase significantly, and the motor carriers experienced a sharp decline in traffic. The Great Lakes were heavily used to transport iron ore, grain, coal, limestone, and petroleum; however, lake shipping was limited by the available supply of vessels and the relatively short navigation season. Barges and tugs were generally too slow to meet the pressing demands of the war; consequently, the inland waterways were not used to capacity. The trucking industry was severely hampered by shortages of vehicles, fuel, tires, replacement parts, and manpower. Some truck traffic was even diverted to the railroads.

No part of the inland transportation system of the United States suffered any war damage. On the other hand, the damage caused by German submarines to domestic coastal and intercoastal shipping had major consequences for the inland modes. The railroads had to haul larger volumes of coal over longer distances. New coal routes to the Northeast had to be established. More freight was transported across country by rail instead of by water transport via the Panama Canal. More than 70,000 aging tank cars were rounded up and organized into symbol oil trains to maintain the vital flow of oil to the East. Nearly 10,000 miles of petroleum pipeline were added to the network, primarily to convey crude oil to the eastern refineries and take some of the pressure off the railroads. By such means, the inland modes were able to offset much of the damage to coastal and intercoastal shipping caused by German submarines. Barges on the

intracoastal waterways, protected from submarine attack, also picked up some of the load.

Ocean transportation was ultimately the logistical factor of greatest importance to the Allied war effort. The movement of troops, military equipment, and Lend-Lease freight to the ports was directly tied to the availability of ocean shipping. More important from the military standpoint, the supply of ocean vessels affected the timing of military campaigns and determined the number of troops that could be sent into the theaters of war.

Together, the government and the transportation industry met the extraordinary demands of the war in excellent fashion, although traffic did not often flow without a hitch. The ODT, the ICC, and the carriers were continually either "putting out fires" or trying to prevent "fires" from occurring. It required constant surveillance supervision, improvisation, cooperation, and coordination to avoid severe congestion and to keep the traffic moving.

5 KOREAN WAR

The war in Korea resembled none of the three previous foreign conflicts involving the United States. The theater of operations was confined to a peninsula of approximately 86,600 square miles in East Asia between the Sea of Japan and the Yellow Sea. The war was much more limited in scope than the two World Wars, yet the United States was involved in its hostilities for nearly three years, compared with less than two years in World War I and just under four years in World War II. In contrast with American involvement in the two World Wars, U.S. armed forces entered the Korean conflict almost immediately after it started. North Korean troops crossed the 38th parallel on June 25, 1950. Five days later, President Harry Truman announced that U.S. Army forces would be sent to the Korean peninsula to aid in the defense of South Korea. The fact that the war was regarded as a limited rather than a full-scale war was another important distinction of the Korean War. The United States sought to stop the aggression in Korea and to prevent a Communist takeover of South Korea. However, the U.S. government was more concerned at that time with the defense of western Europe, and the Department of Defense was not willing to devote so many troops to Korea that NATO's defenses might suffer as a consequence. This treatment of the Korean War as a limited conflict had some important implications for industrial mobilization and the domestic transportation system.

5.1 NATURE OF MOBILIZATION

The United States faced two logistical crises during the Korean War. The first one occurred immediately. The United States had to move enough supplies and equipment to sustain the forces sent to blunt the initial attack and to deny the North Korean government a quick victory. The North Korean forces were advancing southward so rapidly that the United States was forced to use a large share of the Army's existing supply of personnel and materiel in the Pacific. Most of the Army's reserve stocks of ammunition and other supplies left over from World War II were expended in the initial emergency effort. Much of this leftover materiel was stored in nearby Japan. There was not enough time for the government to mobilize the economy for producing and shipping the necessary quantities of weapons and supplies.

After North Korea's initial advance was stalled, the problem became one of restoring the reserve stocks of equipment and supplies that were so badly depleted during the first few months of the war. Existing supplies had been consumed so quickly that, by the autumn of 1950, new production was nowhere near making up the shortfall. To start up ammunition-production lines required one to two years even under the best conditions. Several factors delayed the production of ammunition. At the time, there were shortages of machine tools, special-purpose equipment, aluminum, and other materials needed to manufacture weapons and ammunition. A strike by steelworkers in the summer of 1952 further slowed production. Military planners had assumed that the war would end within a few months. As a result, military orders for supplies were insufficient. The People's Republic of China had successfully intervened on behalf of North Korea in November 1950, and the war had taken on an entirely new complexion.[1]

President Truman did not declare a state of national emergency until December 16, 1950. Nevertheless, at no time during the war was the American economy placed on a full wartime footing. In treating the Korean conflict as a limited war, the government adopted the notion of "creeping mobilization." The idea behind this concept was to increase armaments production without greatly disturbing or disrupting the civilian economy. Consequently, the United States was not the only source of supplies for the United Nations' forces in Korea. A program was implemented to collect and rebuild World War II equipment in Japan. Significant quantities of supplies were also procured from local merchants and manufacturers in Japan and South Korea.[1]

5.2 GOVERNMENT CONTROL OVER TRANSPORTATION

At the start of the Korean War, no government agency existed to direct and coordinate the various modes of transportation during a national emergency. The Office of Defense Transportation had expired on July 6, 1949. Consequently, President Truman, using his authority under the Defense Production Act of 1950, designated the Interstate Commerce Commissioner responsible for the ICC's Bureau of Service as the Administrator of Defense Transportation. The Administrator was given the authority to allocate and determine the priorities for transportation materials and facilities.[3]

5.2.1 Defense Transport Administration

The Administrator of Defense Transportation activated an organization known as the Defense Transport Administration (DTA). The DTA's function was to develop control measures to ensure the most efficient use of all domestic land transportation facilities. Although it operated very much like its predecessor, the ODT, the DTA's field of activity was limited to domestic rail and motor transportation and to storage and port facilities. It did not have any field establishment of its own, nor did it issue any orders in its own name. Rather, it used the offices of the ICC to execute its orders.[3]

5.2.2 Control Measures

The DTA primarily adopted the same kinds of controls as had been used by the ODT. The DTA promulgated minimum loading requirements as a way of overcoming the railroads' chronic shortage of boxcars. It raised demurrage charges to stimulate quick release of rolling stock. It instituted a permit system to regulate the flow of coal hoppers to Lake Erie ports. It also established a priority system to give preference to certain military shipments.[3]

5.2.3 Government Takeover of the Railroads

In July and August of 1950, trainmen and conductors threatened to strike. Acting under his constitutional powers and the authority vested in him by the Army Appropriation Act of 1916, President Truman issued an Executive Order, effective August 24, 1950, placing the Class I railroads directly under the control of the federal

government. For the next 20 months, the railroads ostensibly were operated by the Department of Defense. In this case, however, federal control was relatively insignificant and superficial compared with the situation in World War I. When the labor situation eased, the railroads were turned over to their private owners again.[3]

5.3 WARTIME TRAFFIC

The Korean War had no noticeable effect on freight volumes within the United States. Table 5.1 shows the total annual ton-miles and tonnages of domestic intercity freight traffic for the period from 1946 to 1955. Throughout this period, traffic levels tended to fluctuate. Spurred by the postwar economy, traffic records were set and reset in 1951, 1953, and 1955. Ton-miles and tons of intercity freight rose in 1950, the year in which the Korean War started, after having fallen during the previous year. Freight traffic also increased slightly in 1951. In the following year, however, both ton-miles and tons of intercity freight declined before rising again in 1953. Thus, the Korean War did not produce the sharp, steady year-to-year increases in intercity freight traffic that occurred during World War II.

The Korean War also did not alter any post-World War I trends in the modal distribution of intercity freight traffic. The railroads' share of the total tonnage of intercity freight had been steadily declining since the last year of World War II. In 1949, rail carriers handled 48.5% of all intercity freight tonnage. During the period of the Korean War, the railroads' share continued to drop, from 46.7% in 1950 to 46.6% in 1951, 44.4% in 1952, and 42.4% in 1953.[13] Motor carriers, both regulated and nonregulated, on the other hand, enjoyed a fairly steady increase in their share of the total tonnage of intercity freight following the end of World War II. The percentage of intercity freight hauled by ICC-regulated and nonregulated trucks went from 19.4% in 1947 to 23.7% in 1949. During the Korean War years, it rose from 26.1% in 1950 to 26.2% in 1951, 28.1% in 1952, and 29.5% in 1953.[13] Thus, unlike World War II, the Korean War did not suddenly reverse previous trends in the movement of freight by truck and rail.

5.4 OVERSEAS TRANSPORTATION

As was mentioned previously, the United States took advantage of the proximity of Japan to the war zone to ship supplies to the United Nations forces during the critical early months of the Korean War. Japan was the leading industrial power of the Orient, and in 1950, the U.S. forces in Japan controlled that country's industrial resources. The United States availed itself of Japanese labor and facilities to recondition the large quantities of World War II equipment that were still in Japan and other islands in the Pacific. The United States also purchased enough supplies from Japanese and South Korean merchants and manufacturers to close much of the remaining gap between what was required to maintain the war effort and what could be shipped from the U.S.[1]

During the first weeks of the conflict, the United States tried to establish a mechanism for automatically resupplying its forces with shipments directly from the United States. These attempts were not particularly effective. The shipping time was too long, and the tactical situation was changing too rapidly. Consequently, during the

TABLE 5.1 Domestic Intercity Freight Traffic by Rail, Truck, and All Modes Combined from 1946 to 1955

	Ton-Miles (10^9)			Freight Hauled (10^6 tons)		
Year	Total[a]	Rail[b]	Truck[c]	Total[d]	Rail[e]	Truck[c]
1946	904	602	82	N.A.[f]	1,432	466
1947	1,019	665	102	2,873	1,613	556
1948	1,045	647	116	2,930	1,580	572
1949	917	535	127	2,648	1,284	630
1950	1,063	597	173	3,043	1,421	794
1951	1,177	655	188	3,321	1,547	871
1952	1,145	623	195	3,253	1,447	913
1953	1,203	614	217	3,417	1,448	1,007
1954	1,123	557	213	3,234	1,279	1,033
1955	1,274	631	223	3,567	1,459	1,063

[a]Includes all modes except domestic coastal shipping.

[b]Includes Class I, II, and III railroads.

[c]Includes ICC-regulated and nonregulated motor carriers.

[d]Includes all modes except Class III railroads.

[e]Includes Class I and II railroads only.

[f]N.A. = not available.

Source: Ref. 13.

first few months of the war, efforts were made to automatically resupply the United Nations forces with shipments from Japan.[1]

During the initial period of the war, when the tactical situation was in a state of flux, shipping was nearly chaotic. Ships jammed Korea's harbors, creating delays and lost time in unloading. Often, unessential supplies were delivered while critical items waited to be unloaded. As a result, available shipping was used uneconomically.[1]

After the first few confusing months of the war, the overseas movement of troops and supplies proceeded fairly smoothly under the supervision of the Navy's Military Sea Transportation Service (MSTS). The MSTS provided sea transportation for all the military departments.

Two important new developments in overseas transportation occurred during the Korean War. One was MARINEX, a marine express service for shipping high-priority cargo when air transportation was unavailable. The cargo was top-loaded, when possible, on fast vessels and sent directly to the overseas destination. Another major development in the overseas shipment of military materiel was CONEX, a container express service. Small packages were combined into uniform loads and placed in reusable containers called cargo transporters. These containers could be stacked in tiers of three and could either be loaded onto the deck of a ship or in the hatch. The containers could be transported on standard Army 6 x 6 trucks, commercial or military flatbed or open-top semitrailers, and rail flatcars and gondolas. CONEX saved an estimated 25 to 30 days in the time required to ship materiel from depot to depot.[1]

During the Korean War, the United States shipped 25 million tons of basic supplies into the war zone. Privately owned merchant ships flying the U.S. flag carried 80% of this traffic. The MSTS moved another 15%. Planes airlifted the remaining 5%, which consisted mostly of rockets, launchers, and other urgently needed items.[2]

5.5 SUMMARY

The Korean War had no noticeable effect on the inland transportation system of the United States. The U.S. government treated the conflict as a limited war, and at no time was the American economy fully mobilized for the war effort. The government did take steps to coordinate rail and motor transport, applying many of the control measures used during World War II. The Korean War, however, did not produce any sudden, drastic increases in freight traffic, nor did it alter existing trends in the modal distribution of traffic. Perhaps the most notable transportation development to come out of the war was the use of containerization for shipping materiel overseas.

6 TRANSPORTATION DEVELOPMENTS SINCE WORLD WAR II

Nearly 40 years have passed since the end of World War II and the major challenge it presented to the United States' domestic transportation system. Over that period numerous developments in transportation have occurred, resulting in significant changes and improvements in the transportation system. Many of these changes will undoubtedly determine how well the system responds to a future crisis of similar magnitude.

Nothing reveals the improvements that have been made in transportation over the past 40 years more tellingly than the substantial growth in traffic that has occurred since the end of World War II. In 1944, at the height of the war, the various modes of transportation in the United States together carried 1,088 billion ton-miles of intercity freight.[13] This unprecedented volume of traffic was nearly twice the total volume carried just five years earlier. Handling it required constant surveillance, supervision, improvisation, cooperative efforts, and coordination on the part of shippers, carriers, and the federal government. However, in every year since 1951, the total annual ton-miles of domestic intercity freight have exceeded the record-setting volume of 1944. Together, the various domestic carriers set a new record in 1979, transporting 2,573 billion ton-miles of intercity freight, nearly two and a half times the peak annual volume of World War II.[15] More important, the carriers were able to handle the 1979 traffic without any undue strain on the transportation system and without any additional involvement by the U.S. government.

Many developments account for the greatly enlarged freight-carrying capacity of the present transportation system. The major ones include the continued consolidation and contraction of the railroad network, improvements in railroad efficiency, the growth of motor freight transportation, the construction of the National System of Interstate and Defense Highways (as well as other improvements in the intercity highway network), the development of containerization and intermodal transportation, and regulatory reform. On the other hand, the depletion of the U.S. merchant marine since the end of World War II has some dire implications. These developments are briefly described in this chapter. By comparing the current transportation situation with that existing at the time of World War II, the problems and performance of the transportation system during the war can be viewed from a better perspective, and the capabilities of the current transportation system can be better judged.

6.1 CONSOLIDATION AND CONTRACTION OF THE RAIL NETWORK

The number of Class I line-haul railroads has declined dramatically since World War II. Although hundreds of railroad operating companies have existed and continue to exist, the relatively few Class I carriers have always dominated the industry, owning over 256,000 of the 330,000 miles of track extant in 1979.[16] Through numerous mergers, the ranks of the Class I railroads have dwindled from 132 operating companies in 1939 to just 35 companies in 1981.[17,18]

Although the number of Class I rail carriers has fallen substantially, the average size of these companies has grown steadily. In fact, from the mergers that have occurred over the past decade, several railroad giants have emerged. These giant systems are listed in Table 6.1, along with the miles of track each one operated in 1981. Of the 23 Class I rail systems in existence in 1981, the top five operated over 60% of the trackage.[18]

The consolidation of line-haul railroad operating companies into a few major systems means that freight can be shipped longer distances without changing carriers, thereby increasing the speed of delivery. In 1976, half the carloads of rail freight were handled by only one carrier, and over 80% of the carloads were handled by no more than two carriers.[17] With the formation of a few giant rail systems, coordination and unification of the railroads during a national emergency would appear to be easier now than it was in 1942 to 1945.

As various railroad operating companies merged and consolidated, they also abandoned or eliminated duplicate trackage and many lightly used branch lines. Consequently, the railroads operate fewer miles of main-line track today than they did 40 years ago. When the United States entered the Second World War at the end of 1941, the Class I, II, and III line-haul railways owned 231,971 miles of road.[5] By the end of 1982, main-line mileage was down to approximately 165,000 miles.[15]

The railroads also operate less equipment today than they did during World War II. At the end of 1941, the inventory of rail equipment included 44,375 locomotives and 2,037,378 freight cars.[5] By 1982, there were 15,678 fewer locomotives and 449,841 fewer freight cars.[15]

Although railroads operate fewer cars now than in the past, they use a wider assortment of cars. The conventional boxcar has been de-emphasized, and other types of cars have become more prominent. Between 1960 and 1979, the supply of plain boxcars dropped from 665,120 to 262,986, while the number of specially equipped boxcars rose from 52,970 to 172,685. The number of covered hoppers increased from 67,912 in 1960 to 246,087 in 1979, and the supply of flat cars grew from 94,966 to 146,402 over the same period. On the other hand, gondola cars, open-top hoppers, and refrigerator cars were not as abundant in 1979 as they were in 1960.[16]

While the overall supply of freight cars has been steadily dwindling over the course of many years, the number of freight cars owned by shippers and private car lines has been increasing. At the end of 1941, private car lines and shippers owned 13.8% of all freight cars;[5] as of January 1, 1979, they owned 21.6%.[16] In 1960, nonrailroad companies owned 0.1% of all gondolas, 0.5% of all boxcars, 1.0% of all open-top hoppers, 3.9% of all flat cars, 8.4% of all covered hoppers, 81.7% of all refrigerator cars, 96.3% of all tank cars, and 5.2% of all other types of cars. As of January 1, 1979, private car lines and shippers owned 6.7% of all gondolas, 3.1% of all boxcars, 4.4% of all open-top hoppers, 30.6% of all flat cars, 32.8% of all covered hoppers, 18.1% of all refrigerator cars, 98.5% of all tank cars, and 9.4% of all other types of freight cars.[16] Thus, the shift from railroad ownership to nonrailroad ownership has been greater for some types of cars than for others. It is most noticeable for flat cars and covered hoppers. Conversely, nonrailroad ownership of refrigerator cars has dropped considerably. In 1960,

TABLE 6.1 Major Consolidated Railroad Systems of Class I in the United States in 1981

System	Miles of Track Operated	Portion of Total Trackage (%)	Rank
CSX Corp.	46,060	15.59	1
Chessie System			
Baltimore & Ohio			
Chesapeake & Ohio			
Western Maryland			
Seaboard System			
Clinchfield			
Louisville & Nashville			
Seaboard Coast Line			
Burlington Northern, Inc.	42,728	14.46	2
Burlington Northern			
Colorado & Southern			
Fort Worth & Denver			
Consolidated Railroad Corp. (consolidation of six bankrupt northeastern railroads, including the Penn Central)	39,281	13.30	3
Norfolk Southern Corp.	31,054	10.51	4
Norfolk & Western			
Southern Railway System			
Southern Pacific Transportation Co.	21,478	7.27	5
Southern Pacific			
St. Louis Southwestern			
Grand Trunk Corp.	3,068	1.04	14
Grand Trunk Western			
Detroit, Toledo, & Ironton			
The Steel Roads (owned by U.S. Steel)	2,223	0.75	19
Bessemer & Lake Erie			
Elgin, Joliet, & Eastern			
Duluth, Missabe, & Iron Range			

Source: Ref. 18.

refrigerator cars constituted 33.8% of the fleet of cars owned by private car lines and shippers and were second in number only to tank cars. In 1979, refrigerator cars accounted for only 4.4% of the nonrailroad-owned fleet. Tank cars constituted 48.0% of the cars owned by shippers and private car lines in 1979, while covered hoppers and flat cars constituted 22.6% and 12.5%, respectively.[16]

Diversified ownership of railroad equipment can increase the difficulty of allocating freight cars and coordinating freight-car movements during times of national emergency. During World War II, for example, the ODT and the ICC had to impose special orders and make other special efforts to coordinate and allocate the use of refrigerator cars, most of which were owned by private car lines and shippers.

With fewer miles of track, fewer locomotives and freight cars, and fewer employees, the railroad industry is much leaner today than it was 40 years ago. Nevertheless, rail carriers are hauling much more freight now than they did at the height of World War II. In 1980, the line-haul railroads carried 932 billion ton-miles of intercity freight, a new record (25% higher than the total for 1944).[15]

The railroads have been able to do more with less because of significant improvements in operating efficiency. Table 6.2 compares the operating characteristics of Class I carriers in 1942 and 1981. Compared with those of nearly 40 years ago, freight cars today have a much higher capacity and carry almost twice as many tons per load. The ratio of average load to average capacity shows that freight cars are more heavily loaded now than they were in 1942. The average freight train in 1981 was ten cars longer, carried over twice as much freight, and made much longer hauls than the average train in 1942. The average speed between terminals also increased over the period. The smaller ratio of revenue tons carried to revenue tons originated in 1981 reflects the extensive merging and consolidation of railroad operating companies that has occurred over the last 40 years. Despite the longer average length of haul of a ton of freight, a higher percentage of freight is now moving on single lines. The only negative change shown in Table 6.2 is the much smaller ratio of loaded car-miles to empty car-miles in 1981 compared with the 1942 ratio.

6.2 GROWTH OF MOTOR TRANSPORTATION

During World War II, the motor-transportation industry's share of intercity freight dropped considerably because of shortages of fuel, tires, and spare parts and the resultant heavy restrictions placed on trucking by the U.S. government. After the war, however, the industry rebounded quickly, and over the past 40 years, its share of the intercity freight market has grown substantially. In 1943 trucks hauled only 57 billion ton-miles of intercity freight, which amounted to 5.5% of all domestic intercity ton-miles of freight (excluding that portion moved solely by domestic coastal shipping).[13] Since then, the annual volume of intercity freight transported by truck has grown to the present record of 608 billion ton-miles set in 1979. The latter volume represented 23.6% of all domestic intercity ton-miles of freight produced that year, excluding domestic coastal traffic.[15] Likewise, in 1943, motor carriers hauled only 292 million tons of intercity freight, compared with 1,557 million tons hauled by the Class I and II railroads.[13] In 1978, however, trucks surpassed the railroads by a wide margin, carrying

TABLE 6.2 Operating Characteristics of 1942 and 1981 Class I Railroads

Characteristic	1942[a]	1981[b]
Average capacity of freight cars (tons)	50.5	81.0
Average load of freight cars (tons)	33.2	68.1
Ratio of average load to average capacity	0.66	0.84
Ratio of revenue tons carried to revenue tons originated	2.06	1.64
Ratio of loaded car-miles to empty car-miles	1.69	1.22
Length of haul per ton of freight (mi)		
Individual railways	217.55	381.42
All railways as a system	448.91	626.40
Net tons per train	1,035.0	2,265.0
Net ton-miles per train per hour	16,132.0	43,109.0
Cars per train (excluding caboose)	51.8	61.3
Average speed between terminals (mi/h)	15.8	19.0

[a]Source: Ref. 5.

[b]Source: Ref. 18.

a record 2,260 million tons (39.6% of all domestic intercity freight tonnage), while the Class I and II railroads hauled 1,481 million tons.[15]

As it did 40 years ago, the intercity trucking industry today still consists of a large number of small trucking firms. The exact size of the industry is difficult to determine, because a large majority of the carriers are not for-hire and, therefore, are not subject to ICC reporting requirements. Consequently, it is difficult to determine how the size of the industry has changed over time. In 1979, however, there were 162,460 motor carriers. Of these, 103,334 were private carriers, and the other 59,116 were for-hire. Among the for-hire group, 17,083 were regulated by the ICC, while the remaining 42,033 were exempt from economic regulations. Only 992 of the regulated carriers earned over $3 million in revenues, while 13,337 of the regulated carriers earned less than $500,000; this distribution of revenues confirms that small trucking firms constitute a major segment of the industry.[17]

There were fewer ICC-regulated motor carriers in 1980 than there were at the end of World War II. In 1945, 20,872 trucking companies were regulated by the ICC. The peak was reached the following year, when 21,118 regulated motor carriers were in operation. Beginning in 1947, however, the number of ICC-regulated trucking firms declined almost every year until it reached a low of 15,100 in 1970. The number then rose in each of the following years, reaching 15,144 in 1973, before dropping again to 15,100 in 1974. Since then, the ranks of the regulated motor carriers have been steadily growing. By 1980, the number had reached 17,721, still well below the levels of 1945 and 1946.[17,19]

The freight-carrying capacity of trucks is certainly much greater now than it was 40 years ago, because the dimensions of truck trailers and semitrailers have increased over the years. The average load of Class I intercity common carriers of general freight increased from 10.3 tons in 1955 to 13.6 tons in 1979.[19] With the development of the National System of Interstate and Defense Highways, trucks also travel at higher speeds and over longer distances. In 1947 the average length of haul of domestic intercity freight by truck was 200 miles; by 1982 this length had increased to 538 miles.[15]

6.3 IMPROVEMENTS IN THE INTERCITY HIGHWAY NETWORK

To a large extent, the tremendous growth of the intercity trucking industry since World War II is due to the development of the U.S. highway system. The number of miles of highway has not increased much since 1945, but the quality and capacity of the roadways have increased considerably. Of the 3,012,371 miles of rural roads extant in 1945, only 487,667 miles had bituminous or concrete surfaces. By 1979 the number of miles of rural roads had increased by only 7.0%, to 3,223,710, but the number of miles of bituminous and concrete pavement had risen by 182.7%, to 1,378,805. In 1945 there were only 18,360 miles of road in the rural state primary-highway system with more than two lanes and only 1,916 miles of rural divided highways. By contrast, in 1979 there were 57,960 miles of roads in the rural state primary-highway system with three or more lanes and 49,858 miles of rural divided highway.[20] Table 6.3 shows the progress that has been made in rural highway development since 1956, when the National System of Interstate and Defense Highways was in its early stages of construction.

The Interstate Highway System in particular and the extensive, vastly improved rural highway system in general have fundamentally changed the strategic importance of motor transportation. There are very few incorporated places in the country that cannot be quickly and easily reached by truck. Moreover, with the abandonment of many rail branch lines and the general contraction of the railroad network, trucks offer the only means of freight transportation in many areas of the country. Of the 61,514 places having a population count in 1980, 41,379, or 67.3% of them, had no rail service.[21] These communities are primarily dependent on trucks and highways for the delivery of goods and services. Because of these recent changes in the railroad and highway networks, in any future national emergency involving a full-scale mobilization of industry, motor carriers most likely will have to play a different and more prominent role than the one they played during World War II.

TABLE 6.3 State Primary Highway System in Rural Areas in 1956 and 1979

Type of Highway	Miles	
	1956	1979
One lane (one-way streets)	8	177
Two lanes	369,840	345,579
Three lanes	3,725	2,414
Four or more lanes		
Undivided	2,696	5,688
Divided		
No access control	4,882	12,103
Partial access control	1,964	4,759
Full access control	704	32,996
Subtotal (divided)	7,550	49,858
Subtotal (four or more lanes)	10,246	55,546
Total rural surfaced miles in system	383,819	403,716

Source: Ref. 20.

6.4 CONTAINERIZATION AND INTERMODAL TRANSPORTATION

One of the most noteworthy developments in freight transportation to occur since World War II has been the use of standardized containers for ocean transportation. Introduced during the Korean War, containerization greatly facilitated the shipment of supplies to the war zone. Since then, it has had a profound impact on port and terminal technology, particularly in the development of new cargo-handling equipment and new types of vessels. The use of standard containers has also fostered the development of intermodal systems of transportation, thereby improving the interface with motor and rail transportation.

The number of containers available for use in the United States has risen sharply in the last few years. In 1974, there were 441,854 containers of all types. By 1977, the number had grown to 569,682.[22] In the following two years, the number of containers of all sizes more than doubled, to 1,433,788.[19] These containers are owned almost exclusively by leasing firms and ship lines.

Another significant development in intermodalism that has occurred since World War II is the trailer-on-flatcar/container-on-flatcar (TOFC/COFC) or "piggyback"

service provided by most Class I railroads. Begun in the early 1950s, this has become one of the fastest growing types of rail service offered. The number of TOFC/COFC car loadings has gone from 168,150 in 1955 to 2,338,527 in 1983. In 1971, piggyback car loadings accounted for 5.4% of all car loadings of freight, exceeded only by the number of car loadings for coal, metallic ores, chemicals and allied products, and crushed stone, sand, and gravel.[23] The 2,338,527 TOFC/COFC cars loaded in 1983 accounted for 12.4% of all car loadings, exceeded only by the number of cars loaded with coal.[24]

Two types of transcontinental TOFC/COFC service have been developed. One type, known as "land-bridge" service, involves the movement of containers between Europe and the Orient via rail across the United States. The other type, known as "mini-bridge" service, involves shipping freight in standard containers between the U.S. east coast and the Orient or between the U.S. west coast and Europe via rail and ocean vessel.

Freight shipped via piggyback service tends to move over longer distances. The average length of haul of piggyback traffic is over 1000 miles, compared with 587 miles for carload traffic in general.[16]

In times of national emergency, when fuel for trucking might be limited, piggyback service would provide a highly effective way of coordinating truck and rail transportation in the movement of merchandise freight over long distances. A primary function of motor carriers in such a situation would be to move freight between communities that are not served by a railroad and the nearest railroad terminals.

6.5 DECLINE OF THE U.S. MERCHANT MARINE

The United States emerged from the Second World War with the largest fleet of commercial oceangoing vessels in the world. At the end of 1946, the U.S. merchant marine consisted of 4,767 dry-cargo vessels and 1,065 tankers, for a total of 5,832 ships of 1000 gross tons and over.[14]

The United States has not maintained its maritime leadership. Maritime Administration figures for 1982 show that this country's merchant marine now ranks eleventh in size. Only 574 privately owned vessels flying the U.S. flag were registered in the United States in that year. In contrast, the Soviet Union had 2,449 merchant vessels and was ranked third in the world.[25]

In previous overseas wars, ocean transportation has always been the most critical link in the logistical system. In each of these wars (except for the war in Korea), the United States has always had to scramble for ships at the start of its involvement. The American shipbuilding industry was able to meet the challenge in both the First and Second World Wars. Nevertheless, it would appear that the erosion of the U.S. merchant marine since the end of World War II is undermining the nation's security.

6.6 TRANSPORTATION AND REGULATORY REFORM

In recent years, the U.S. government has made some major changes in the regulation of the transportation industry. These changes have given rail, motor, air, and intercity bus carriers greater freedom to set rates and more flexibility to operate their services. The recent regulatory reforms have greatly increased the competitiveness of the transportation industry, both within and between modes.

The most important effects of the regulatory changes on the railroads have been in the area of rate-making. The Railroad Revitalization and Regulatory Reform Act of 1976 promulgated new standards for determining whether proposed new rail rates were just and reasonable. It also established a zone of reasonableness within which carriers had some freedom in changing rates. The Staggers Rail Act of 1980 provided even greater freedom from maximum rate regulation by establishing zones of rate flexibility within which rates could be changed without ICC interference.[17]

In times of full-scale industrial mobilization, however, flexibility in rate-making is less important than operational flexibility. The Staggers Rail Act of 1980 eases some of the restrictions on the day-to-day management of the railroads, but it also contains provisions concerning rail operations during regional and national emergencies. For example, the Act restricts ICC car service orders to regional or national emergencies only. It expands the ICC's authority to require joint use of terminals during emergencies by including all terminal facilities under the order. To improve car use the Act allows the railroads to charge premium rates for special services.[17]

The Federal Motor Carrier Act of 1980 also contains numerous provisions designed to improve the efficiency of domestic freight transportation. The Act requires the ICC to eliminate all gateway restrictions and circuitous-route limitations within 180 days of its effective date. It also establishes a framework for expediting the removal of other restrictions on interstate trucking, such as restrictions on the kinds of commodities that individual carriers can haul, restrictions on serving intermediate points on a carrier's route, authority to haul goods in one direction only, territorial limitations, and other restrictions that are inefficient, waste fuel, or are contrary to the public interest. In deciding on an individual carrier's request for removal of various types of operating restrictions, the ICC now has to consider the effects of the removal on fuel consumption, costs, efficiency, and the provision and maintenance of service to small and rural communities and small shippers. The Act also provides for the movement of both regulated and exempt commodities in the same vehicle at the same time without affecting the regulatory status of either type of traffic. The Act adds certain commodities to the list of exempt commodities to make it easier for transporters of agricultural products to backhaul freight to areas of agricultural production, thereby improving the efficiency of vehicle use and lowering the cost of transporting farm products.[26]

Some of the provisions of the Federal Motor Carrier Act of 1980 were designed to foster better coordination and cooperation among the motor carriers. The Act gives the ICC new authority to require the motor carriers to interchange traffic. It allows the ICC to prescribe through rates, joint classifications, and joint rates whenever such are considered to be in the public interest. The Act also makes it easier for two common

(motor) carriers to pool or divide traffic, services, or any part of their earnings. Such arrangements can now be approved without a hearing unless the ICC determines that the pooling agreement is of "major transportation importance" or "unduly restrains competition".[17,26] These provisions would be especially useful during times of national emergency.

The Federal Motor Carrier Act of 1980 made promotion of intermodal transportation a federal policy. Several provisions of the Act implement this policy. To encourage greater use of containerization, used pallets, used empty shipping containers, and other used shipping devices are now exempt from economic regulation. The ICC now has the authority to require motor carriers to establish through routes and joint rates with water carriers. Unfortunately, this provision does not extend to rail carriers as well. On the other hand, freight forwarders are now permitted to enter into contracts with rail carriers and common (water) carriers for certain transportation movements. Trucking companies may now interchange trailers with railroads for TOFC service at any point on a rail carrier's route, provided that the motor carrier making the interchange is authorized to serve the origin and destination points of the traffic.[26] These regulatory changes affecting intermodal transport would also be extremely useful during times of national emergency and full-scale industrial mobilization, when unification of the transportation system is crucial.

One other recent change worth noting in the federal regulation of transportation involves truck size and weight limitations. With the Surface Transportation Assistance Act of 1982, the federal government for the first time established uniform truck size and weight limitations on the Interstate Highway System. Permissible truck weights on interstate highways are now 20,000 lb on any one axle, 34,000 lb on tandem axles, and 80,000 lb gross weight for vehicle combinations of five or more axles. On interstate highways and certain designated roads in the Federal Aid Primary System, trucks may now pull trailers 48 ft long in truck tractor-semitrailer combinations and trailers 28 ft long in truck tractor-semitrailer-trailer combinations. States are not allowed to prohibit "double bottoms" or truck tractor-semitrailer-trailer combinations from operating on these roads, nor are they allowed to impose limits on the overall length of commercial motor vehicles operating on these designated highways. In addition, the federal government has imposed a nationwide vehicle-width limitation of 102 in. on interstate highways and certain other roads in the Federal Aid Primary System. The effect of these uniform size and weight limitations is to permit the operation of bigger and heavier trucks on many of the nation's highways. More important, these regulations will greatly expedite the flow of interstate truck traffic. In the past, differences in truck size and weight limitations among the various states limited the size of some long-distance truck shipments. Motor carriers often followed less direct routes to avoid states that had especially restrictive size and weight limitations. By setting uniform size and weight limitations that are applicable nationwide, the federal government has cured one of the motor-carrier industry's major headaches.

6.7 SUMMARY

Since the end of World War II nearly 40 years ago, numerous transportation developments have occurred that could greatly affect the way the transportation system performs in any future national emergency of similar magnitude. Because of many technological developments and improvements in the transportation infrastructure, the domestic transportation system as a whole has for many years now been accommodating more tons and ton-miles of intercity freight than it was able to handle at any time during the Second World War. Particularly noteworthy are the improvements that have been made in the highway system over the past 40 years. The development of the Interstate Highway System has certainly been one of the major factors behind the rapid and continued growth of the motor transport industry since the close of World War II. Because of the interstate system and the general contraction of the railroad network, trucks can be expected to play a more prominent role in any future national emergency than they have in previous ones. Perhaps even more important than the development of the national highway network have been the recent developments in intermodal transportation. The rapid growth in containerization and TOFC/COFC rail service has led to more efficient port operations, faster long-distance rail service, and better coordination between modes, all of which are crucial during periods of full-scale industrial mobilization. Recent regulatory reforms, particularly those applying to motor carriers, also foster better efficiency and both intramodal and intermodal cooperation and coordination. In contrast to these positive developments, the United States' fleet of commercial oceangoing vessels has declined appreciably since the end of World War II. If the experiences of past overseas conflicts are any indication, this latter development could substantially negate many of the advances in domestic transportation made over the past 40 years.

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INITIALISMS

AAR	Association of American Railroads
AEF	American Expeditionary Force
AMTC	Allied Maritime Transport Council
ARA	American Railway Association
CONEX	Container express service
CTC	Centralized traffic control
DTA	Defense Transport Administration
FY	Fiscal year
ICC	Interstate Commerce Commission
LCL	Less-than-carload
LTL	Less-than-truckload
MARINEX	Marine express service
MSTS	Military Sea Transportation Service
ODT	Office of Defense Transportation
OPA	Office of Price Administration
PAW	Petroleum Administration for War
PUC	Port Utilization Committee
SFAW	Solid Fuels Administration for War
TOFC/COFC	Trailer-on-flatcar/container-on-flatcar
VMT	Vehicle miles of travel
WFA	War Food Administration
WPB	War Production Board
WSA	War Shipping Administration

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